THE

Practical Teacher

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'*Knowledge is proud that he has learned so much,*
Wisdom is humble that he knows no more.'—COWPER.

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Hygiene.

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WATER—(*Continued*).

THE effects of an impure supply of water are now too well known to be insisted upon here. They differ according as to whether the water is contaminated with sewage products and other animal refuse, with organic materials, such as decomposing vegetable matter, or with inorganic substances. Sewage in potable water, sooner or later, will produce certain effects, such as irritable mucous membrane, lassitude, diarrhœa, and anæmia, ending at length in continued or enteric fever, or cholera. Other organic impurities produce dyspepsia, loss of appetite, erysipelas, and dysentery. In hot climates yellow fever and other zymotic diseases are caused by the use of polluted water, different kinds of entozoa have been spread by it, and parasitic diseases set up in both men and animals. The Elephantiasis of the East has been ascribed to its use. The continued use of a water which contains excess of saline constituents will also produce different kinds of mischief. Diseases of the skin have been ascribed to the continued use of mineral waters, and similar states in the mucous membrane of the bowels may arise. Goitre appears to be due to the use of water from the magnesian limestone formation. This has been denied by some, though the evidence in the negative is not satisfactory. Sulphate of lime will also produce dyspepsia and other disorders when it is in excess, and disease of the bones have been set up, especially if SO_2 happens to be present. The use of water which is too pure is also said sometimes to have promoted the production of rickets. This has been ascribed as one of the results of the use of the Loch Katrine water in Glasgow; but it is denied by some who speak with authority, as not being sufficient to account for the presence of that disease in the northern metropolis of commerce.

MINERAL WATERS.

These waters used to be mainly taken at the suggestion of medical authorities, but they are now so commonly consumed as beverages, that it is right to give some information as to their character, and the results which are likely to follow from their continued employment. They were prescribed by Esculapius, and are mentioned by all the early medical authorities as useful adjuncts to treatment.

Mineral waters are divided into different classes by different authors. The simplest classification is into thermal or *hot springs*, and *cold waters;* but this division is unchemical. The best division is that adopted by 'Braun,' viz. :—

(1) Carbonic acid waters.
(2) Saline waters.
(3) Sulphur waters.
(4) Earthy mineral waters.
(5) Irregular or indifferent.
(6) Chalybeate waters.

I would add to this—

(7) The Iodo-bromated waters.

(1) *Carbonic acid waters.* This class is not, as generally understood, a natural class: there are a few springs which contain small quantities of saline ingredients with excess of CO_2, but they are evanescent. These waters are manufactured articles, and constitute the ordinary soda or potass, and other bottled waters, which now so properly appear on the dinner-table, in addition to or in place of alcohol. It is said that the excess of CO_2 chemically assists the solution of the bicarbonates, lessens gastric irritability, acts upon the secretions of the stomach and kidneys, and thus promotes the removal of *débris* from the body.

(2) *Saline waters* are subdivided into (*a*) *simple alkaline waters*, which contain carbonate of soda (Na_2CO_3) as its principal mineral constituent. Vichy is the most noted representative. Vals, Bilin, Apollinaris, Salzbrunn, Mont Doré are in the same class. (*b*) *Chloride of sodium waters*, in which common salt is dissolved with the alkalies: it includes Ems and La Bourboule. (*c*) *Bitter waters*, which contain more or less of the sulphates of soda and magnesia, such as Friedrichshall, Hunyadi-Janos, Pullna, Seidlitz, and (at home) Epsom, Beulah Spa, Streatham, Purton Spa, Cheltenham, Leamington, and Scarborough. (*d*) *Compound soda waters:* in this division we have Carlsbad, Marienbad, Franzensbad, and some less known. (*e*) *Simple salt waters*, of which Homburg and Kissingen are the most noted. There are also Wiesbaden, Baden-Baden, Kreuznach, and also Droitwich in this country.

(3) *Sulphur waters.* These waters contain sulphuretted hydrogen, in alliance with different salines; most of

them are natural baths in high ground, with doubtful climates. Those in the Pyrenees are most noted, but Aix-les-Bains, Aix-la-Chapelle, and the British sulphur springs of Harrogate, Moffat, and Llandindod are important. These waters are sometimes chalybeate as well as antacid and diuretic.

(4) *Earthy mineral waters* are found at Weissenburg, Leukerbad, Wildungen, and Insebad. They have excess of lime and magnesia, with silica and iron.

(5) *Indifferent waters* are those without active chemical ingredients, such as Buxton, which is a warm water, with great quantities of nitrogen and very little saline. Bath is somewhat similar, but warmer, with more solid constituents. The position of Buxton differs, however, from Bath in its elevation above the sea-level, being 900 feet; abroad there are Teplitz, Plombières, Ragatz, Gastein, and Wildbad.

(6) *Chalybeate waters* obtain their notoriety from the quantity of ferrous carbonate in solution. Exposure to the air allows the escape of the CO_2 which held the iron in combination, oxygen is absorbed, and the iron falls as an hydrated ferric oxide.

Many of the preceding springs are also chalybeate, such as, among alkaline waters, are Ems, Salzbrunn, Bilin, Apollinaris. Alkaline salines have Marienbad, Franzensbad. Those more decidedly saline include among the chalybeate list, Kissingen, Wiesbaden, Baden-Baden, and Kreuznach; almost all the principal watering-places have chalybeate spas, but those most in use are Spa (in Belgium), Pyrmont, Schwalbach; and in our own country, Tunbridge Wells, and Harrogate; whilst at Brighton, Malvern, Bournemouth, and Sandown springs are found slightly impregnated with iron.

(7) *Iodo-bromated waters* are a small class containing iodine and bromine in minute quantities. They are found at Kreuznach, Woodhall Spa, and Purton Spa, a small village in North Wiltshire which promises to be a valuable addition to this class of Spas in this country.

It is the custom for certain classes of invalids to go to health resorts, both at home and abroad, for the purpose of 'drinking the waters,' and clearing their constitution from maladies which are the result of various causes, such as luxury and indolence, or of over mental and cardiac strain, the wear and tear of business, or active professional life, or merely because it is a fashionable thing to do.

Much of the benefit which results from this custom arises from the complete change of habit which the patient undergoes, for the responsible advisers at those resorts take care to insist upon early rising in the morning, so as to diminish the relaxing effect of too much sleep, and to strictly inculcate temperance in eating and drinking, as well as the free use of the diluent. The major portion of the waters act as resolvents, scouring the mucous membrane of the bowels, and sometimes acting freely on the kidneys, and thus are blood purifiers to a large extent, whilst in some cases active exercise is also insisted on by local physicians, by which the skin is made to freely perspire, and the capillary vessels become unloaded, as well as the vascular system of the mucous surface in the bowels.

The most aperient class are Hunyadi-Janos, Friedrichshall, Carlsbad, Pullna, Kreuznach, Kissingen, and Ems, whilst Apollinaris, Seltzer, and Vichy are used for dietetic purposes to a very large extent. To these must also be added, potass, soda, and lithia waters, which are now generally at hand in all well-regulated establishments, for the purpose of diluting wines, and diminishing the incidence of free living. In these waters the alkali is held in combination with an excess of CO_2 under pressure. The excessive use of aerated waters is not to be commended in every kind of constitution, and at all seasons, but when a man suddenly gives up his beer and takes to water, because he is no longer able to digest beer with comfort, or for any other reason, it is wise to take a sufficient quantity of liquid to replace that which the individual was accustomed to take, otherwise the so-called abstainer will find himself, after a time, not so well as he might be for his change of habit.

It is now established that alkalies increase the secretion of gastric juice, and so assist digestion, but when used for this purpose they should be taken before a meal, but if there is acid eructation, and a state of flatulency after food, the use of small doses of alkali in the form of a mineral water is very beneficial. The most perfect type of a mineral water is that produced by Packham and Co., of Katharine Street, Croydon, whose manufactory is the perfection of order and cleanliness. The various waters are made up with distilled water, to which a fixed quantity of the various salts which constitute the natural waters, are carefully added so as to imitate the natural water as closely as possible, except in one point—they are completely freed from the organic matter which too often pollutes the natural springs. The quality is always the same, and in practice I much prefer to order waters manufactured at that establishment, and so obviate the risk of giving my patient an attack of typhoid fever or diarrhœa, by advising them to drink some of the abominations which are said to be bottled at the springs. Healthy men and women do not require mineral waters, but they are very useful in chronic functional disorders, in debility, whether the sequence of some general disease, or in the early stages of organic disease, and in all cases in which the appetites of men have taxed their digestive organs beyond their natural power; but we must bear in mind that a too long continuance of salines, especially in cold weather, is liable to upset the digestive organs, as well as put them right. Packham's Hedozone, a phosphated iron tonic, is superior to any of the natural chalybeate waters, and without asserting that our local manufacture is far superior to any other for the manufacture of artificial aerated waters, I am quite satisfied from personal knowledge of the purity of the articles bottled there, and I fully endorse the observations made by the *London Medical Record* and the *Lancet* as to the safety with which they may be moderately used by those who labour under any kind of weakness of the digestive organs.

ALCOHOLIC BEVERAGES.

These are now so often diluted by mineral waters that we may refer to them here.

Alcohol is a powerful medicine taken in a full dose in any form. It dilates the capillaries, causing a passive congestion, delaying the progress of the blood from the periphery of the body back to the heart, and thus for a short time relieves that organ of its work; but by delaying circulation, it prevents the removal of used-up matters, and retains *débris* within the current

of the blood, or within the cells which ought to be engaged in the active duty of removing the waste. Alcohol delays tissue-change, and may therefore be used when oxidation is in excess of the requirements of the body, or when food is not forthcoming to supply waste, but it is not in itself a food, and cannot be so considered. Its use, under certain circumstances, may, as it were, assist a lame dog over a stile, but by continual use the lameness will never depart, and the stiles will be more and more numerous, for it prevents the very action which is necessary to remove the cause of the lameness out of the system—viz., unoxidised *débris*. It is possible that a diet drink of pure malt and hops may have a small amount of food in the extraction and salts which it contains, but pure malt and hops are not now attainable, and since the Legislature has allowed the use of molasses in the manufacture of the national drink, its comparatively harmless nature has departed, and as with the introduction of molasses, the use of various bitter extracts besides that of hops becomes common, and the source of which extracts the chemist cannot detect, the use of beer is likely, in the course of time, to go out of fashion. Even the working man is finding out its noxious quality. I was conversing upon this point with an extensive brewer the other day, and he told me that he believed the soil of the hop-growing districts in this country was becoming exhausted, and that brewers could not get the same results from a pocket of Kent hops as they used to do, and as a consequence they were obliged to use other vegetable bitters. Be that as it may, from personal experience I believe the use of molasses will eventually destroy the national beverage, as, since that change has been made, with me it undoubtedly promoted the rheumatic diathesis, and I was obliged to give up its use. Natural wines, manufactured from the simple juice of the grape, and without fortification or the addition of a 'bouquet,' may be comparatively harmless in moderate quantities, and even beneficial under certain circumstances; but it is a difficulty to get such. The haste to be rich by making large profits leads to sophistication and adulteration, and as a consequence the human race suffers. As a rule, I prefer to drink water. If I can get it pure, so much the better, and if it is not pure I prefer to have it boiled and used as tea or coffee, or with some such addition as toasted bread, to the use of the abominations which are put into bottles, which have various deadly poisons drawn from the amylic-æther series of compounds added to them for the purpose of giving 'bouquet' to the odour, and making believe that they are something *recherché*, when they are only mixtures of several spoilt vintages and chemical manufactures after all; and their æsthetic properties are less than moonshine, for they make things appear to be what they are not, and alter things that are for the worse and not the better.

(To be continued.)

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THE Conference on Education to be held at the Health Exhibition promises to be one of unusual importance. Papers will be read on various topics relating to school work. A glance at the list lately published shows that many of the best-known educationists in this country have given their support. Representatives from Belgium, France, Germany, and Switzerland are also expected. Teachers who intend to spend their holiday in London will have a rich treat in store.

The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

IN last month's issue of this magazine will be found a sketch of the course of easy lessons in zoology which, it appears to me, may well be included in the 'Elementary Science' for Standard IV. I also gave the outlines of Lesson I., on the distinction between vertebrata and invertebrata; and of Lesson II., on the classification of the former sub-kingdom into the five classes—mammals, birds, reptiles, amphibians, and fishes. I now propose to take the lessons in each of these classes, beginning with the lowest—viz., fishes. Leaving out of consideration the skeleton, we shall describe the main characters of the members of the various groups under these four heads:—(1) Circulation; (2) Respiration; (3) Skin-covering, etc.; (4) Manner of Birth.

LESSON III.

FISHES (Circulation and Respiration).

Place before the class the school-picture (Murby's set) of the organs of a fish. Carry on a conversation about the picture, and point out the heart, gills, and air-bladder, scales, fins, and roe. Then cut open a fresh-herring, and show the organs represented in the picture.

(1) Circulation.—Note the small heart just under and in rear of the gills. Heart has *two* chambers, one auricle and one ventricle. Our heart has *four*. Impure venous blood from all parts of the body of the fish enters the one auricle, passes to the ventricle, goes to the gills, where it is changed into pure arterial blood, which then passes to a large artery called the aorta, from which it is distributed over the body of the animal.

(2) Respiration — Breathing.—*We* breathe air. Fishes also breathe air. But *we* breathe the air as it is. Fishes breathe air dissolved in water. Air is soluble in water. Experiment:—Half fill a Florence flask with water. Shake it up: some of the air dissolves in the water. Heat the water—not to the point of boiling—over spirit-lamp: note the minute bubbles of dissolved air being driven out of the water by the heat. Air is a mixture of nitrogen and oxygen. Boys have learnt this already. The nitrogen and oxygen do not dissolve in water in the same proportion as they exist in the air. More oxygen dissolves than nitrogen—*i.e.*, oxygen more soluble in water than nitrogen. (This, by the way, is a striking proof that the air is a mechanical mixture of gases, and not a chemical compound.) Fishes breathe this oxygen which is dissolved in the water in which they live. Water is gulped by the fish. This water passes over the gills. The blood in the gills absorbs the oxygen which is dissolved in the water. (Note:—The boys know that water is H_2O, and they will think that the fish obtains its supply of O by the decomposition of water. Guard against such error.) *We* use up the oxygen of our air, and return carbon dioxide (CO_2). Fishes also use up the oxygen dissolved in water, and return to the water CO_2. (Note:—CO_2 very soluble in water: instance soda-water.) Aerial plants remove the CO_2 which *we* exhale, and aquatic plants in like

manner absorb the CO_2 which fish exhale. Hence water of fish-globes, or aquaria, must either be often changed or aquatic plants, *e.g.*, watercresses, must be allowed to grow in the aquarium. Explain the position and probable use of the air-bladder.

LESSON IV.

FISHES (Skin-covering, etc., and Manner of Birth).

Have the picture as before, and two fresh-herrings, a hard roe and a soft roe. Recapitulate a few facts respecting circulation and respiration, and then proceed to notice :—

(1) Skin-covering and Fins.—No hair on a fish. Scrape off a few scales. Show that if a scale were *fringed* on its edge, and the horny part contracted to a middle ridge down the scale, we should have something not unlike a little feather. This for future reference when we come to speak of the feathers of birds. Note the two pairs of fins, the pectorals and the ventrals; these answer to the four limbs of other vertebrates.

(2) Manner of Birth.—Hard-roed herring, the female. Soft-roed, the male. Hard roe, a collection of what will become eggs. Not eggs while in the body of the fish. (Note :—Some people will not eat a hard roe for fear the ovules should turn to fish in their digestive organs. A mistaken notion.) Compare the ovules in the ovary of a flower. Boys have already learnt this in previous lessons. These ovules become seeds when the pollen from the anthers has fertilized them. Explain that the hard-roed herring deposits some of its roe upon a water-plant or a stone in the water. Soft-roed herring comes and deposits upon this hard roe some of its soft roe. Then the ovules become eggs, from which little fishes are hatched. I find that boys who have kept 'stickle-backs' have really noticed all this.

(3) Note that the lowest fish—the lancelet—can scarcely be said to have a backbone at all, nor a heart; so closely are fishes connected with the sub-kingdom invertebrata. While the highest organized fish—the mud-fish—has not only gills, but also lungs for breathing the air as *we* do; and is thus closely connected with the next class of animals above them—viz., amphibians.

LESSON V.—AMPHIBIANS.

Frogs, toads, newts, salamanders, etc. Show picture of the organs of a frog, and have before the class the school aquarium, if there be one. Carry on a conversation about a frog, and get from the boys all they know about this animal. Then proceed to note :—

(1) Circulation.—(*a*) As a tadpole its circulation is the same as that of a fish. Recapitulate what this is. (*b*) As a fully-grown frog, the heart has three chambers: two auricles and one ventricle. Impure venous blood from the body enters the right auricle, passes to the ventricle, thence to the lungs, absorbs the oxygen of the air, and is changed into arterial blood, which returns to the ventricle; in this chamber there is consequently a mixture of venous and arterial blood. This half-oxygenised blood is then distributed over the system. Hence a frog's body feels so cold. Amphibians, like fish, are cold-blooded animals—*i.e.*, the blood is colder than the surrounding medium; ours is warmer.

(2) Respiration.—(*a*) In the tadpole state, the respiration is by gills, the same as a fish. (*b*) As a fully-grown frog, it is by lungs, as is the case with us. Here explain the word 'amphibian,' 'both lives'—that of fish and that of reptile. Note :—Dispel the common error in defining an amphibian, as 'an animal that can live in the water and on the land.' It will be soon apparent that the boys consider such an animal as the 'seal' an amphibian.

(3) Skin-covering, none. Limbs four, formed for swimming.

(4) Mode of Birth.—From eggs or spawn deposited in the water, generally upon aquatic plants; nearly the same as in the case of fish. This is given with sufficient fulness in the Science Reader.

LESSON VI.—REPTILES.

These are—(1) crocodiles and lizards; (2) snakes; (3) tortoises and turtles; of which the highest in the scale are crocodiles, and the lowest, tortoises and turtles.

(1) Circulation.—Like that of a frog; but at no period of its life does a reptile possess a heart of two chambers; always of three or four. There are two auricles and one ventricle, through which the circulation is the same as that of a frog, and the blood is cold. But in the case of tortoises, turtles, snakes, and lizards, there is a sort of beginning of a division of the one ventricle into two parts by the growth of an incomplete septum; this septum is, in the case of crocodiles, quite perfect; and here we have a heart of four completely distinct and separate cavities. This is extremely interesting, and the boys will easily grasp the fact by the aid of a few rough sketches on the blackboard.

(2) Respiration.—Never by gills; always by lungs. Hence a reptile cannot, in breathing, obtain its necessary supply of oxygen from the air dissolved in water, but always *directly* from the atmosphere, as we do.

(3) Skin-covering.—Thick scales, as in the case of turtles, etc., or strong horny plates, as in tortoises. Never feathers, nor hair.

(4) Mode of Birth.—The young is hatched from an egg. About April or May the female crocodile lays about twenty eggs, generally in the warm sand by the side of a river. She is a careless mother, and scarcely covers up the eggs. The little ones are hatched quite alone, and are five or six inches long. After a few days the mother finds them, and leads them to the mud on the river bank, and feeds them. The father takes not the slightest notice of them.

(To be continued.)

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Article 106 (*b*).

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

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Section II.—Phenomena of Nature.

LESSON—FROST.

WHEN we talked about the rain the other day, you said you liked it to come sometimes. Will you tell me when it is that you like the rain? That is quite right, when it

has been hot we like the rain to fall. Why? Because it makes the air cool. When do we have very hot weather? In the summer. Then it is in the summer that you like the rain. Which part of the year do we have most rain? Yes, we have very much more rain in the winter than in the summer. What kind of weather do we have in the winter? Cold weather. One winter's day it had been raining very much; the gutters were full of water, and a tub and some pails in the garden also had water in them. All that night the wind blew, and it was very cold. In the morning when I went out I felt very cold; the pavements were dry, and instead of water in the gutter, I saw something that I could stand on. It looked very bright, and was very smooth. Do you know the name of it? Yes, it is called 'ice.' How did the ice get there? Well, listen. You know there was water in the gutter, and that the weather was very cold. Well, this cold weather turned the water into ice. I went into the garden afterwards, and found ice covering the top of the tub and pails, and I found the water in the water-jug frozen. What do we mean by frozen? We mean the water has ice on it. Now, if I wanted to get some water out of the tub, what should I have to do? You would have to break the ice. What should I find? The water under the ice. What can you tell me then about the ice? It is at the top of the water. Yes, the water only freezes at the top. Sometimes the ice is very thin, and sometimes it is very thick. Can you tell me why this is so? It is thick when the weather is very cold. Yes, and if the weather keeps cold, the ice gets thicker, and it is then very hard and strong.

Where is the water kept that we use in the house? In the cistern. How does it get into the cistern? Through little pipes from the street. Can you see the pipes in the street? No, they are under the ground. Yes, they are very large, and being in the ground the water does not freeze. The water in the small pipes, however, often freezes; and then what happens? The cistern is empty. What do you have to do then? Mary says her mother asks the lady next door. Perhaps the lady next door is without water, and then what do we have to do? We must look out for the man who puts a pipe up in the street. Yes, the turncock puts a pipe in the street, and then the water comes up out of the big pipes under the road. What do you do then? Our mother or big brothers and sisters take the pails, and cans and jugs, and get them all full of water. What does your mother do? She sees that everything is full of water; and she will not let us play with it. No, we must all be very careful indeed when the frost is hard. Do we use much water? Tell me some of the things for which we want water. We want water for washing ourselves, our rooms, our clothes, and things we use; for cooking some of our food, for drinking, etc. Yes, you see then it is very awkward to be short of water. Does it always rain before it freezes? No, sometimes it is quite dry. How can we tell it is freezing? By the cold weather. And any other way? The ground gets very hard, and if there is any water about, it gets covered with ice.

I daresay some of you have seen the water in the parks. What do we call this water? Ponds and lakes. Well, sometimes when it is very cold these lakes and ponds are frozen over with thick ice. Do you know what some people do then? Yes, they go on the ice, and slide and skate. They like this very much indeed, and it keeps them very warm. The teacher might here point out the difference between sliding and skating, and should it be convenient, a pair of skates should be shown to the children.

Do little children go out when it is freezing? Yes. What do their mothers do to them? Wrap them up in very warm clothes, and tell them to run about. Why must they run about? To keep themselves warm. Sometimes I see little children crying, but that is because they walk or stand about instead of moving about quickly. Do you know any good games for cold weather? Tell me the names of them. The teacher should here caution the children about the danger of making slides on the paths, etc. Have you ever seen cabmen and other men that drive horses beating their arms in the winter? Show me how they do this. Why do they do it? Because they are cold. Yes, they have to sit still and drive, and, therefore, they get very cold unless they move their arms about.

Sometimes the frost looks very pretty, especially in the country, on the grass and trees. The frost covers the branches with white, something like snow, but there is only a little of it, and it is very fine. When the sun shines the branches seem to sparkle, and look very pretty. It looks just as if the trees were covered with powdered glass. You might think it was fine white sugar.

One morning after the frost had lasted a long time, the weather became warmer, and your mother turned on the tap, and found little drops of water coming out. After a time these drops came quicker and quicker, and at last the water began to run out again like it did before the frost came. Then she went into the garden, and found the ground was softer. Can you tell me what made the water run again and the ground get softer? Yes, the warm weather. Yes, we say it is the *thaw*, and we always have this after a frost. When does the frost go away? When the rain comes, or when the weather gets warmer. Does the frost always come in the winter-time? Do you know what we call the time when the flowers begin to come on the fruit trees? Yes, the spring. Sometimes the trees are all full of bloom, and the farmers think they will have a fine fruit season, but the frost comes back, and then what do you think happens? It freezes the blossom. Well, we do not say the blossoms are frozen; we say the frost kills the blossom, and that means the blossom will not turn into fruit.

Section III.—Scenes of Common Life.

LESSON—MARKETS.

I. *Introduction.*—The teacher should question the children as follows:—Where do you buy meat? At the butcher's shop. Where do you buy potatoes, greens, apples, oranges, etc.? At the greengrocer's. Where do you buy fish? At the fishmonger's.

II. *The Markets.*—Now, can you tell me where the butcher gets all the meat he has to sell? From the market. And where the greengrocer gets his fruit and vegetables? And where the fishmonger gets his fish? Yes, that is right, they all get their things from the market. Do they all get their things from the same market? No; the butcher gets meat from the meat market, and the fishmonger gets fish from the fish market, and the greengrocer gets fruit and vegetables from another market. Can you tell me what a market is? Well, it is a very large place with a great many shops in it; the shops are quite close together, and in the meat market every shopkeeper sells meat; in the fish market every shopkeeper sells fish. Why do the shopkeepers go to the market to buy the things they sell? Because they can buy enough to fill their shops—as much as they want. Could the butcher go to a shop and buy so much meat? Then he can get the meat very much cheaper at the market—if he were to buy it at a shop, he would have to pay just the same money for it as he would have to sell it for. That would not do at all. Why not? Because he would have all the trouble of fetching the meat and selling it, and would gain no money.

Do any other people buy at markets besides those who keep shops? Yes, any one can go into a market and buy. When do the shopkeepers go to buy? Early in the morning, then they have their things ready in their shops for people who wish to buy of them: but other people can buy in the daytime in the market. Why does not everybody buy at the market? Because it is too far off. Is it 'too far' from everybody? No; some people live near the market, and they generally buy at the market. Why? Because they get their things cheaper.

Now, you have told me that shopkeepers get their things from markets, I wonder if any one knows from

where the people in the markets get them. Well, I will tell you. Do you know what the men who keep a great many sheep and cows and bullocks are called? No, they are not butchers. What do the butchers have done to these animals? They are killed for them to sell. The men who keep these animals until they are ready to be killed are called farmers. Do you know where these men live and look after their animals? In the country. Yes, they have very large fields where they grow grass, corn, and other food for the cattle. The farmers send the animals to the cattle markets, and the butchers buy them, and when killed they are sent to the meat market. Sometimes the animals are killed in the country, and then they are sent to the meat market, instead of the cattle market.

Now, can any one tell me from whence the fish comes? From the sea. How is it got from the sea? What are the men called who catch fish? They are called fishermen. These fishermen catch the fish, and send it to the market, and the fishmongers go there to buy it.

Perhaps some one can tell me where the fruit and vegetables come from. Yes, they also come from the country. If you go into the country you may see large fields of potatoes, other fields of cabbages, others of peas, others of strawberries, and other things sold by the greengrocer. Sometimes you may see some trees with apples on them, some with pears, and some with plums; under these trees you will see bushes with gooseberries, currants, etc., growing on them. What is the man called who looks after all these things? A gardener. What does the gardener do with his things when they are ready for use? He sends them to market. If the market is not too far away, the gardener packs his vegetables in very large waggons. I saw some very large waggons the other day packed quite full of cabbages, and not only in the waggon, but a long way up above. How do you think the men keep these from falling off? Yes, they were tied round very firmly with rope. The waggons were going along very slowly because they were very heavy loads for the horses. They start in the evening, and go on walking all night, then they get to the market very early in the morning, ready for the shopkeepers who come to buy.

III. *Principal Markets of London.*—Now I should like you to tell me the names of some of the markets in London. Yes, the meat market is one, but that has a name. Does any one know what it is? It is called Smithfield. Has any one been to Smithfield? What do you see there? That is right. Meat, fish, poultry, bacon, and cheese. What do you mean by poultry? We get all these things at Smithfield, but you must remember there are really three markets here—one for meat, one for fish, and the other for poultry, bacon, cheese, etc. I dare say some of you have seen a great many carts full of hay at Smithfield. This is called the hay market.

Can you tell me of another market? Yes; there is another fish market called Billingsgate, and another one called Columbia Market, but fruit and vegetables are sold in Columbia Market as well as fish.

Do you know the name of a fruit and vegetable market? Yes; there is one called Farringdon Market, and there is a very much nicer one called Covent Garden. Has any one been to Covent Garden Market? What did you see? Then there are some markets where potatoes only are sold. These are called potato markets. There is one at Spitalfields. Does any one know where the cattle market is?

Then there is Cumberland Market for hay and straw, and the Corn Market at Mark Lane.

The names of the markets should be written on the blackboard, and if the children have had lessons in elementary geography, the map of London shou'd be placed before them, and the position of the markets pointed out.

Section IV.—Common Employments.

LESSON—THE SHOEMAKER.

I. *Introduction.*—What covering do we have for our feet? Boots and stockings. Why do we wear these? To keep our feet warm. What is the use of stockings? To keep our feet and legs warm. Could we go into the streets with stockings only on? Why not? They are not thick enough to keep out the cold, and they would let the wet through, and if we were to tread on a stone it would hurt our feet. The boots do not let water through, and they are hard, so that if we tread on a stone it would not hurt us. Now we are going to talk about the boots to-day.

II. *Materials and Tools used.*—You see I have a boot for you to look at, and what is this? A shoe. Of what are they both made? The children should repeat 'Boots and shoes are made of leather.' What is the man called who makes boots and shoes? What must he have in order to do his work? He must have tools. I have some of the shoemaker's tools on my table, you shall tell me all you can about them. The teacher might then point to the different tools, and if the children do not know them, tell them their names, and write them on the blackboard.

Now, perhaps some of you could tell me how the shoemaker uses these tools. Who has ever seen a shoemaker at work? What was he doing? Well, John, you say you saw him hammering. What was he hammering? The heel on a boot. Was the heel ready-made, and the man hammered it on? No, he nailed one thin piece of leather on, than another piece on that, and then others until the heel was high enough. Who can show me the heel of this boot? Can you see the different layers of leather? Did you see, John, what the shoemaker had inside the boot while he was making the heel? What shape is the last? Can you tell me the use of it? Yes, the shoemaker always puts it inside the boot when he has to hammer nails in it. It would be very awkward to hammer the boot without something firm inside. Have you ever seen the man put a sole on a boot? That is done much in the say way as the heel is done, but there are not so many layers of leather as in the heel.

Mary says she saw a shoemaker sewing. Did you notice what he did to the thread before he used it? He rubbed something on it. Well, here is the something; what is it called? Why does he rub the wax on the thread? It makes it very much stronger. Have you ever seen any one else use wax? Yes, sometimes your mothers do, if they want their work to be very strong.

For what does the shoemaker use the pincers? Show them to me. Now show me the awl. What is the use of it? The man makes holes in the leather with the awl, and then he puts his needle through. Why does he not put the needle through at first? Because the leather is too hard.

What are these little things called? Pegs. Of what are they made? For what are they used? Instead of sewing the boots, men sometimes peg them; that is, they hammer the soles on with these little pegs. Which are the stronger, sewn or pegged boots? Yes, the sewn are the stronger, and we generally have to pay more money for them.

What is the use of the knife? To cut the leather. Have you ever seen the bootmaker use paste? What did he do with it?

Now, I must tell you that it is very seldom that one man makes a boot entirely himself. Generally, different parts are given to different people to make. Some parts are made by women. What do we call this part of the boot? The uppers are generally made by women, and they require other tools besides those we have mentioned, but those you must learn about another day. Some shoes are bound like this (showing a shoe); this is done by women, and the inside of the boot, the lining, is also done by women.

When the different parts of the boots are made, they are put together by men.

(To be continued.)

The Discipline of the Mind.

BY W. C. COUPLAND, M.A., B.SC.,

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IV.—The Processes of Reasoning.

A familiar contrast of common discourse is that of Thoughts and Things. The one term is usually taken as the summary of the contents of an individual consciousness excluded from the outer world; the other stands for a realm of existences equally secure from the invasion of spiritual forces. A very little consideration, however, shows the necessity of a revision of this time-honoured Dualism, the conventional distinctions failing, on closer inspection, to retain their sharpness of definition. 'Things' attentively regarded, appear tinged with Thought, and many so-called 'Thoughts' present themselves clad in material vestments. In other words the Real and the Ideal are found interfused, and a subtle analysis is required to yield the contrasted elements in their strict purity. A *Perception* is such a case of fusion, and a glib Dogmatism may easily be made to stammer on being challenged to assign the phenomenon its place in either of two mutually exclusive spheres. For, if the swift answer be, 'The Thought-realm, of course,' the compliance with the further request for a brief description of the other half of the Universe of Common Sense may be awaited with interest. Or should a less confident election be, 'The province of Things,' the pitiless Sphynx of Speculation who devours all easy-going Materialism will propound the puzzle, 'What is the matter of knowledge without the form of knowing?'

My purpose in these introductory remarks to the present section is not, however, to lead the reader into the hazy region of Metaphysics. My object was simply to induce a personal examination of those ever-recurring terms, *real* and *ideal*, in order to prepare the student for a full recognition of the *psychological* truth that the larger part of all apparent knowledge is charged with ideal elements; that what seems immediate apprehension is (say) one-tenth immediate, but nine-tenths mediate or indirect. Waiving the metaphysical question whether there be any non-mental reality, it is quite certain that the larger part of what we at any time characterise as *perceived object* is matter of inference from certain indications directly intuited. To an ordinary being possessed of eyesight the world of immediate apprehension is prevailingly a world of coloured visible forms, the objects directly discerned being enriched by attributes which frequent association has shown to be more or less regular accompaniments of these ocular phenomena. To the man smitten with blindness, on the contrary, tactile impressions overbear all others, as the world in which he moves and has his being; and memories of colour and visible form invest the nucleus of palpable fact, giving rise to an aggregate which is only differenced from that entering into the consciousness of the normal human being by the transposed vividness of the components. The ordinary man talks in terms of vision. He 'sees' and 'intuites' with the inward eye as with the outward; the blind 'feels' and 'grasps' his truth. But whether normal or abnormal, the portion added by imagination is by far the larger ingredient in all perception of objects; and a thorough training of the mind has to commence the logical discipline at this first stage of converse with the outer world.

The errors we commit in obtaining a real knowledge of the world are chiefly errors of classification, or of mistaken identification. Accurate knowledge of an object implies adequate distinction of parts, and faithful assimilation of actually observed with identical remembered qualities. So far as the primary sense-endowment and the sufficient exercise of the senses are concerned, this subject has already been considered; but a careful training of the Senses only carries us a little way towards the goal of real knowledge, or a just apprehension of the relation of sense-experiences. The disciplined senses having given in their report, imagination at once essays to fill out the picture, and the understanding proceeds to assign the object its place in the system of known things. As, however, sense may be confused, so imagination may exaggerate, and the judgment may be disordered. The imagination, of which we here speak, in the train of ideas representing former sensations which have been previously associated with the sensations now present. These associated ideas are dragged into the forecourt of consciousness in conformity with the 'Law of Contiguity,' and their procession is so swift and unbidden that they seem like a portion of the actual sensation, it even requiring an effort to convince ourselves that we do not actually see the solid block, or encounter the resistance of the impenetrable object. Equally prompt is the classifying function of the intellect. To speak, indeed, of this recognition of the object as something different from its mental construction verges almost on the tautologous. For in the very act of evoking sensations from the pit of memory we are pronouncing a tacit judgment that 'Here is an object possessed of marks presented by members of a certain class.' However, as this reference to a class is exceedingly important in the development of knowledge, it still seems desirable to consider this act of judgment as a distinct moment in the progress of perception.

As then we recognise two psychological processes subsequent to the original impression, a discipline of the mental powers will provide for the imperfect performance of these processes. In the first place, we should be able to separate the additions of imagination from the primary elements of sense. I believe I am correct in saying that this is a training of the powers almost entirely neglected in the education of the young. But it is difficult to conceive anything more important than the habit of distinguishing between what we directly observe and what we fancy we observe. Does it require so profound an acquaintance with psychology to make a child carefully distinguish the impressions he is receiving at any moment through eye or ear, and the qualities which his unreflective consciousness take to be equally revealed through the senses active at the moment, as (say) the distance, the hardness, and weight of a remote object?

There will be a further gain from this habit of analysis. It being once well understood that our perceptions are largely ideal, that is, are the joint product of actual sensations and remembered sensations, it will come to be admitted that the accretions of imagination may form so large a part of the whole, that the

classifying of the object may more depend upon them than on the actual intuition. In the next place, then, the mind must be accustomed to control its identifications, must not yield to the first suggestions of the presentation, but must be alive to the possibility of bias through the circumstances of the environment, or the condition of the faculties at the time.

In affirming an object to be this or that, I perform the simplest act of reasoning. The ground of my affirmation is the resemblance between certain properties believed to be present, and similar properties manifested on former occasions. In truth, my inference is freighted with a double chance of error. I believe that the imagined attributes are really there on the strength of certain felt sensations, and I believe that the object thus *perceived* is one of a class of objects which I have already formed by previous acts of comparison, that it is correctly *conceived*. A very slender thread of reality may bear a huge superstructure of belief. Of course the only final and sufficient test of the correctness of my inference is the elimination of the ideal elements by reducing the perception to sensation; but when such reduction is impossible (as in most cases it is), I must be content with guarding the process of inference by all the precautions logic is able to supply.

The perception is Sensation *plus* Idea, the conception is Idea pure and simple. Conceptions are the resembling constituents of a number of perceptions, which the mind has detached by a process called Abstraction, and which are made permanently available for comparison and inference, by being associated with certain conventional signs or names. It is in the operation on these symbols of idealised perceptions that reasoning in the narrower sense consists. But before we wholly leave the ground of reality it will be advisable to pay some attention to a mode of inference which plays a very large part in our daily life.

There is an unconscious kind of reasoning where we conclude from one special case to another on the bare superficial resemblance of the facts or circumstances. There is more than contiguous association, for it is the similarity that arrests the attention, but the inference is not extended beyond the particular instance, and the mind does not attempt to generalise its experience. It is not improbable that the brutes never get beyond this concrete reasoning, and certainly children and even adults of an unreflective turn of mind proceed largely upon these isolated identifications. But with the growth of the mind, observations are consciously generalised, and in place of concluding to a particular conjunction on the strength of another similar conjunction, the intellect infers to a class of indefinite extent, although the number of observed instances be but a fragment of the whole. This operation is called Induction, and its importance is at once seen when we consider how very few assertions of a universal character we should be entitled to make if we had to wait until we had examined every actual example.

There is a kindred mode of inference where the resemblance is one of depth rather than of breadth, and a conclusion is drawn on the strength of a certain number of common properties. We know (say) that two objects are alike up to a certain point, but are in the dark with regard to other agreements; one of the objects, however, possesses a further property. We then assume that the other object when better known will also be found to possess the same property. This kind of reasoning, which is known as Analogy, differs from Induction proper by the stress of the argument falling on the relative number of known and unknown properties in a very few objects; whereas in the latter case the inference is to the possession by a whole class of a particular attribute on the ground of its possession by a certain number of individuals.

Having arrived at a general truth by inferring that what is true of A and B and . . . . will be true of all objects that resemble A and B and . . . . in certain determinate characters, we may henceforth draw conclusions without further appeal to experience. Having affirmed possession of a property by class X (composed of objects known and unknown), we can predicate the possession of the same property by any object that falls within the description of the class. This is the species of reasoning termed Deduction, and though in this condensed statement the process may seem sufficiently evident, in reality its exercise often demands the highest tension of mind. It may be by a sudden perception of resemblance, a lightning flash of intellect defying all rule, that a grand principle is seized in a host of particulars, but the application of this principle will often tax the severest powers of thought. The axioms or fundamental principles of the sciences are soon reached, but the thorough-going application of such principles may constitute the main body of the science. Thus, take two sciences at the opposite ends of the scale, the science of simple quantity, and of economic values. The theorems of discrete quantity in the science of mathematics can be enunciated and proved by the mathematician confined to his room with (say) a pencil and a few sheets of paper. With a few conventional symbols and strenuous thought, long trains of reasoning may be carried on by him—the last link in the chain as certain as the first. Again, the laws of human industry, the theorems of commercial exchange, and principles of distribution of wealth may all be derived from a few familiar facts of human nature and a small number of fixed conditions of physical and mental life. And even the sciences which are most dependent on natural observation and experiment come with progress of time to be more largely deductive, and the development of rational conceptions will probably at some late stage of human history supersede induction by the aid of perception. As we see in Physics, not so long ago wholly experimental, entire branches are now cultivated mathematically or symbolically.

Science is but methodised common knowledge, and Reasoning is one and the same, whatever the sphere in which it is exercised. It is either good or bad, legitimate or illegitimate, according to the closeness of the resemblance of the attributes compared. The equivalence of geometrical figures is seen at a glance, and hence the inspection of a single diagram will supersede all further appeal to intuition, and we confidently universalise our theorem. Less exact will be our inference in the case of physical objects. A carefully performed experiment will compel conviction, but the question will always have to be raised anew: does the substance now before us perfectly resemble that on which we previously operated? When we come to the complexity of organic beings we are in more danger still of drawing inferences from superficial semblances—a trustworthy diagnosis often requires a very skilled physician.

Logic is the discipline of the rational power, and its importance in the higher education has always been recognised. Rather strangely, however, it has no place in the common school curriculum, an omission probably due to mistaken ideas as to its scope and nature. I can imagine only one ground on which this neglect might be attempted to be justified. It might be said that for the youthful mind the *matter* is more important than the *form* of knowledge, that the reasoning powers are best cultivated by working in the concrete, and that to abstract the process of reasoning itself, and make it an object of distinct consideration, would be as ill-advised as the teaching of grammar before practical familiarity with the forms of speech. There is truth in this, but it does not wholly hit the mark; for a logical discipline is practicable which is highly material, where examples drawn from the concrete are worked with, and the contact with reality is as close as in any study of mathematics or of polite literature.

For the teaching of logic in schools probably the usual order of treatment should be inverted, and an examination of fallacies form the first topic. A consideration of the methods actually employed in the branches of knowledge studied by the pupil would follow, and the doctrine of the syllogism might, perhaps, be profitably ignored. This may sound somewhat revolutionary, but the question of procedure is for the present of minor importance. When teachers in general come to undergo a logical training, prior to exercising their vocation, their estimate of the worth of the discipline may be expected to undergo great change. But, whatever the fate of logic may ultimately be, as regards general education, there can be no doubt about its importance for the teacher personally.

There is no lack of text-books on logic, but, considering the lavish expenditure of energy in this direction, it is astonishing how few writers succeed in giving a clear notion of the province they undertake to teach. Old errors are propagated from treatise to treatise, and the really knotty points are slurred over as if the province of the science itself was as well defined as that of plane geometry. This confusion is doubtless due to the slavish adherence of the human mind to traditional precepts; accordingly when the expansion of the sciences called for the recognition of hitherto neglected modes of reasoning, the new methods were simply tacked on to the old, without any perception of incoherence or felt need of enlarging the list of fundamental principles.

The first essential for clearness is to distinguish between pure logic and real logic: that is, between those inferential processes which deal with given premisses, and those methods of arriving at truth which cannot be comprehended without a full understanding of the subject-matter. The former half of the science is closely analogous to algebra, and is occupied with the equivalence of convertible statements and the establishment of relations through the media of common terms. Although a seemingly elementary exercise, the practice of deriving equivalent truths from other truths is one which, if thoroughly familiar, would save a great deal that passes for very forcible reasoning.

The venerable type of Reasoning known as the Syllogism, where from two truths, of which one, at least, is universal, a third truth is derived, has of late in some quarters received scanty respect, and as a transcript of common argumentation undoubtedly has but little to say for itself; but if treated as the formal aspect of a real Deduction, will never lose its importance.

The department of Pure, or Formal Logic, requires for its mastery a large practice of examples. If it be desirable to put the youthful intellect through an algebraic text-book, where the real value of the symbols employed is hardly ever explicitly considered, *a fortiori* one would think it should be well to see the laws of consistent thinking illustrated in the language of every-day life. But the student-preceptor, for his part, will not stop here. Having mastered the mysteries of the syllogism, the consideration of the nature of truth itself will be forced upon his mind, and he will be driven to take note of that all-important distinction between real and verbal truth, between truth of mere thought and truth of fact. When the wide interval between these two kinds of truth has become clear to him, he will be prepared to pass on to the study of that other department, which I have designated Real Logic, where we seek to obtain an insight into those rules whereby we do not simply achieve a harmony with ourselves in the recesses of our private consciousness, but endeavour to secure an agreement with the thoughts of all other minds.

Objective, or Real Logic, presupposes that there are Laws of Nature—Uniformities of Succession and Co-existence; and the office of the science is to shape our belief in accordance therewith. Pure, or Formal Logic, is a science regulative of *Thinking*. Self-consistency is its end and aim, and error means overstepping the limitations and conditions inherent in the thinking faculty itself. It usually takes the form either of implicitly denying that a part of a part is a part of the whole, or of in effect asserting that the mind can unite contradictory attributes in an indivisible act of thought. Hence, with full consciousness, a fallacy of pure reasoning is impossible. Thinking signifies no other than direct or mediate comparison of ideas. But while we cannot combine or disjoin the materials of thought erroneously, except by inadvertence, it is quite possible to *believe* mistakenly, even with the fullest development of self-consciousness. To regulate belief, there is no resource but to study the order of the world, and to submit to the teaching of Experience. Now, the rules of Material Logic are nothing but safeguards for the preservation of the mind's sanity in this perilous pursuit. In other words, it is pretty well equivalent to 'The Theory of Evidence.' To ascertain what sort and amount of evidence is sufficient for an assertion, when we are entitled to universalize a limited experience; to graduate assent according to some more reliable principle than the strength of the impulse to credulity or incredulity itself—such, in brief, is the end of this truly difficult, but most necessary discipline.

(To be continued.)

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Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

X.—(*continued.*)

These heretics were to be expelled from the country. The friends had but a narrow escape from personal violence, and, of course, considered it high time to provide for their own safety. So Barop proceeded to the seat of the Government, to seek protection.

Most cordially was he received by the leading members of the Council. The high merits of the petitioners were duly acknowledged. 'It is a hopeless struggle,' said the President, Herr Pfyffer, 'that struggle of yours against ignorance and superstition. There is only one means to provide for your safety: convince the masses by an examination, as thorough and as public as possible, of the excellence of your system, and your enemies will be silenced if not subdued. Then, and then only, will you be safe.'

That sage advice met with a hearty response. The petty warfare had been minutely chronicled in the public papers; it was canvassed in every nook and corner of Switzerland, and the impending battle excited the liveliest interest among all classes.

It was a beautiful day in the autumn of 1833 when the long and anxiously awaited trial took place. In countless numbers the people assembled from far and near, even from Zurich and from Bern. The cantonal Governments sent deputies. From seven o'clock in the morning until seven in the evening the most rigorous examination was held. The boys entered upon their task with so much animation and delight, they answered all the questions in so frank and so unembarrassed a manner, that all present were astonished, and in rapturous acclamations gave vent to their joyful surprise; but when the drilling exercises and the games came off, the countenances of the parents beamed with pride and delight, and the general enthusiasm knew no bounds. The battle was won, and Fröbel's victory was complete and decisive.

Enthusiastic speeches were delivered by Pfyffer, Amrhyn, and others, the members of the governing Councils. The matter was considered in an official Council, and the chateau was granted at a merely nominal rent. The Capucins, who had desecrated the pulpit by preaching sedition and violence, were ignominiously expelled from the country.

Not long after, a deputation came from the Canton of Bern, requesting Fröbel to establish a school in the orphan-house at Burgdorf, the very same place where Pestalozzi's star had risen. Fröbel proposed not to confine the plan to orphans only, and this suggestion was readily accepted. It was arranged that Middendorf should take Fröbel's place in Willisau, and be assisted by Ferdinand Fröbel, whilst Langethal, who had followed his friend to Switzerland, accompanied Fröbel to Burgdorf. Barop, considering his mission completed, returned to Keilhau. For a full year did that man leave home and wife, in obedience to the Divine call within him! Shortly after his departure a child had been born to him, whom he had not yet seen. Fröbel himself had sacrificed his family life while in Wartensee, since his wife could not be spared from Keilhau; Middendorff left his wife and his young family for four years, until the Willisau establishment was summarily suspended, when the Jesuitical party secured the reins of government! What remarkable instances of faithful devotion to the sacred cause which these men had espoused! 'When I now come to think of it,' Middendorff used to say, 'I hardly understand how it could have been done, yet I felt like a soldier in war at a dangerous post, I could not and dared not give way. The clergy advanced too fiercely, and with their heaviest cannon, and how could I have thought of running away on mere personal considerations?'

After all his changes and meanderings he seemed to have reached, at Burgdorf, the long-hoped-for safe port. What he had imagined his special calling—a sphere of labour like that of Pestalozzi, yet entirely shaped to his own ideas—he found here open before him. Step by step he had been patiently climbing up the steep mountain, and now that he had reached what he had considered the summit, he discovered a still higher peak, one which fascinated his whole being. Here it was that, in the summer of 1835, Fröbel and Langethal entered upon their duties. Fröbel was appointed director of the Orphan-house, and, as such, had also to superintend the studies of the teachers of the canton. These enjoyed, every third year, a three months' vacation, to repeat and continue their educational studies at Burgdorf under their now far-famed master. That was a glorious time for Fröbel and his wife. Never in all their lives did they feel happier and more at ease. Unmolested by secret or open enemies, unfettered in his labours by official meddling, unoppressed by worldly cares, Fröbel's great mind expanded and revelled in his own world of educational and philanthropical aspirations.

Here it was that he arrived at a new stage of his eventful life. In his intercourse with so many teachers he gained a deeper insight into the inner life of school and family. The latter especially he learned more emphatically to look upon as the real, the all-important keystone of human progress. He was convinced that the family, and not the school, ought to be considered in the first place, and that the school could not prosper unless the family had properly paved the way. Mothers are the first trainers of mankind; to their pure hands are entrusted the highest interests of civilisation, and mothers must be trained for their high calling. This now became his watchword.

This was not a new idea: Napoleon had long ago expressed the same thought to Madame de Campan. Besides, there is no such thing to be found as a new principle in education. Truth may be clothed in a new garb, and may be brought home by new means, or new pathways, but truth itself is eternal.

'The family, the family,' now began to occupy all his thoughts. 'The spiritual must be embodied in materials, in order to develop the child in conformity and in unity with God, with nature, and with mankind!' A good many such materials he had already invented and planned; but where was the beginning to be? The primary, where was it to be found? Which was naturally the first plaything? which the first joyful pastime of the child?

Like a divine inspiration the answer flashed upon him, when once his eye fell upon a party of children playing at ball. Yes, of course! Was not the globular the primary form of all life in nature? And, since all life (in nature) is one, all obeying the same laws, and since the child is part and parcel of nature, must not his development strictly obey the same laws?

The starting-point once found, it was to Fröbel an easy matter to reach his old familiar basis. The 'law of opposites' left him no doubt about it: the ball, the cube, and the intermediate link, the cylinder, these were the three original forms, the very elements of all mechanical contrivances. The subject fascinated him, he was as if in an enchanted garden; the crowning of all his life's labours and aspirations appeared to him an unmistakable reality. *The child at home* seized his imagination—held him spell-bound—him, that no child called father, and made him proclaim to all the

world: 'The whole is foreshadowed in the part, the general in the particular, the man is like an embryo in the child.* All human development has its germs in early childhood; the life of man is the necessary outcome of his treatment as a child! Come, let us live for our children!'

Through all seeming errors and mistakes, through all his many vicissitudes, and disappointments, and trials, he had been most carefully trained for the peculiar purposes of Providence. There was, however, this warning voice of calm reasoning: Might he not be justly charged with inconsistency, when he, ever restless, again changed his sphere of action? After so many grave experiences, might not the voice of worldly wisdom have a just claim to his earnest attention, or were idealistic aspirations to have for ever an unchecked sway over him?

By a supreme decree that natural struggle, if it ever was allowed to occupy his thoughts long, was soon terminated by a dark and dismal cloud.

(To be continued.)

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Chemistry of the Non-Metallics.

BY EDWARD AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

EXAMPLES ON BOYLE'S LAW (*for Solution*).

(9) Twenty cubic centimetres of gas are measured off under normal pressure. The pressure is increased 140 millimetres. What is the volume of the gas?

16⅔ cc.

(10) The pressure is equivalent to 3040 millimetres. It is reduced to 3000 millimetres less. Find the change of volume undergone by 80 cubic centimetres.

Expansion = 6 cubic decimetres.

(11) Three litres of gas are to be reduced to 500 cubic centimetres. If the original pressure is 1½ kilograms, find the final pressure.

9 kilograms.

(12) A Boyle's tube has a short limb with length = 1 decimetre. Find (*a*) the difference of level of the mercury that has been poured into the tube; (*b*) the whole length of mercury in the tube when the mercury in the short limb is 4 centimetres from the closed end.

1140 mm.; 1260 mm.

(13) What is the length of the short limb of such a tube that when altogether 2400 millimetres length of mercury have been poured in, the air in the short limb may occupy 2 centimetres length?

8 cm.

The general principle spoken of on page 11, can now be considered. It is found, as the result of experiment, that

gram.		mm.		litres.
1 hydrogen at 0° C, and under		760	pressure, occupies	11·2
16 oxygen	„	„	„ occupy	„
14 nitrogen	„	„	„ „	„

Compare the numbers 1, 16, 14 with those in the list on page 12 opposite hydrogen, oxygen, nitrogen. They are identical. And, generally, *the number of grams of any element gas represented by the weight-number of the element occupy at normal temperature, and under normal pressure, 11·2 litres.* This special volume, 11·2 litres, is often called 1 volume or a volume.

* 'The child is father to the man.'—*Wordsworth.*

EXERCISES ON THE LAW OF VOLUMES AS REGARDS ELEMENTS (*Solved*).

N.B.—Unless any statement is made to the contrary the pressure and temperature are assumed to be normal.

(24) The number of litres occupied by 71 grams chlorine gas at 0° and 760 mm.

35½ grams Cl. occupy 11·2 litres
1 gram Cl. occupies $\frac{11\cdot2}{35\cdot5}$ „
71 grams Cl. occupy $\frac{11\cdot2}{35\cdot5}\times 71 = 22\cdot4$ litres.

(25) The number of cubic centimetres occupied by 77 grams nitrogen (at normal).

14 grams N. occupy 11·2 litres = 11,200 cc.
1 gram N. occupies $\frac{11200}{14}$ cc.
77 grams N. occupy $\frac{11200\times 77}{14} = 61{,}600$ cc.

(26) The volume occupied by 80 grams oxygen (at normal).

16 grams oxygen occupy 11·2 litres
1 gram O. occupies $\frac{11\cdot2}{16}$ „
80 grams O. occupy $\frac{11\cdot2\times 80}{16} = 56$ litres.

EXAMPLES ON THE LAW OF VOLUMES AS REGARDS ELEMENTS (*for Solution*).

(14) The volume occupied by 1 decigram hydrogen 1·12 litres.

(15) The volume occupied by 1 gram oxygen ... 7 decilitres.

(16) Weight of 1 litre nitrogen ... ... 1·25 grams.

(17) Weight of 3 cc. hydrogen ... ... $\frac{1}{11\frac{1}{9}}$ grams.

We return to our first typical equation that represents the formation of hydrogen from zinc and sulphuric acid, and write under the symbols the weight-numbers as calculated on page 81, and the volume of the only gas concerned, hydrogen. A volume = 11·2 litres.

$$Zn + H^2So^4 = ZnSo^4 + H^2$$
$$65 + 98 = 161 + 2$$
2 vols.

Fully translated, therefore, this means that 65 parts by weight (say grams) of zinc treated with 98 parts by weight of sulphuric acid yield 161 parts by weight of zinc sulphate + 2 parts by weight or 2 volumes (say twice 11·2 litres) of hydrogen.

EXERCISES ON THE PREPARATION OF HYDROGEN FROM ZINC AND SULPHURIC ACID (*Solved*).

(27) Required 56 litres of hydrogen. What weight of zinc must be used?

2 vols. = 22·4 litres hydrogen require 65 grams zinc.
1 litre „ requires $\frac{65}{22\cdot4}$ „
56 litres „ require $\frac{65\times 56}{22\cdot4} = 162\frac{1}{2}$ grams zinc.

(28) 77 grams sulphuric acid are poured on a mass of zinc. What weight of the metal is dissolved and what volume of hydrogen is given off?

98 grams H^2So^4 dissolve 65 grams Zn. and liberate 22·4 litres H.
1 gram „ dissolves $\frac{65}{98}$ „ „ ..... $\frac{22\cdot4}{98}$ „
77 grams „ dissolve $\frac{65\times 77}{98}$ „ „ ..... $\frac{22\cdot4\times 77}{98}$ „

$51\frac{1}{7}$ grams zinc, 17·6 litres hydrogen.

EXAMPLES ON THE PREPARATION OF HYDROGEN FROM ZINC AND SULPHURIC ACID (*for Solution*).

(18) 26 grams of zinc are dissolved in sulphuric acid. What volume of hydrogen is evolved? ..... 8·96 litres.

(19) Required 80cc hydrogen. What weight of zinc sulphate is formed at the same time? ..... $\frac{1}{11\frac{1}{9}}$ grams.

(20) 1 kilogram, 3 hectograms zinc are dissolved. Find weight and volume of hydrogen evolved.

4 decagrams : 4 hectolitres, 4 decalitres, 8 litres.

To sum up all that should be learned from this first preparation of the element hydrogen.

(*a*) The laboratory method of preparing it (page 81).
(*b*) The symbols $Zn + H^2SO^4 = ZnSO^4 + H^2$.
(*c*) The metric system of weights and measures (page 119).
(*d*) The weight numbers in the reaction $Zn(65) + H^2SO^4(98)$ yield $ZnSO^4(161)H(2)$.
(*e*) Thermometers.
(*f*) Barometers.
(*g*) Boyle's law.
(*h*) The law of volumes as regards elements.
(*i*) The volume in this reaction H_2 (2 vols., or 22·4 litres) are evolved when 65 grams of zinc and 98 grams of sulphuric acid are placed together under appropriate conditions.

SECOND PREPARATION. FROM WATER AND POTASSIUM OR SODIUM.

(1) Laboratory method. Prepare a pneumatic trough, beehive, and gas jars as directed on page 81. Place in the water a piece of red and a piece of blue litmus paper. These are blotting-paper stained with certain vegetable colours. Also a piece of turmeric paper, which is paper stained yellow with an extract from the turmeric root. Note that the colour of none of these three pieces of paper is changed by the water. Taking care that your fingers are dry, cut off with a dry knife a piece of the soft metal potassium. Place it within a cage made by folding together a piece of wire gauze with meshes not too fine. Hold the cage by means of a strong wire—about twelve inches long. Taking an inverted gas-jar filled with water in one hand plunge with the other the cage containing the potassium beneath the surface of the water and below the mouth of the jar. The potassium decomposes the water, taking the place of part of the hydrogen in that compound, and forming a new compound of potassium, hydrogen, and oxygen, called potassium hydrate, or potassium hydroxide, or, commonly, caustic potash. I prefer the first name, for reasons that will be better understood by and by. The hydrogen gas set free bubbles up into the gas-jar, displacing the contained water. The blue litmus paper is unchanged; the red is turned blue, and the yellow turmeric paper brown. Hydrogen oxide (or water) and potassium have yielded potassium hydrate and hydrogen. If sodium is used instead of potassium, sodium hydrate, or sodium hydroxide, or caustic soda is formed.

(2) Symbols $2H^2O + 2K = 2KHO + H^2$ (*good*).

The student will note that the reaction might *apparently* be represented by exactly halving the symbols, and writing—

$$H^2O + K = KHO + H \text{ (\textit{bad})}.$$

But this would give us a symbolic representation of the evolution of *one* atom of hydrogen. And on the views at present held by chemists a single atom of an element gas cannot exist alone. An *atom*, represented by the symbol of the element written alone, without any figure, is the smallest part of an element which can exist in combination. Thus potassium hydrate consists of three atoms, one of potassium, one of hydrogen, and one of oxygen. A *molecule* (moles = mass, icula = diminutive ending), or little mass, is the smallest part of an element, or compound, that can exist alone. Usually, a molecule consists of two atoms. Thus H^2 represents a molecule of hydrogen. In representing reactions by symbols, care must be taken never to represent a single atom of an element gas as existing alone. This only applies to gases. A solid or liquid element may be represented by its symbol without any figure. Thus in the bad equation given above K is not incorrect, and in the good equation 2K is written, but H^2.

(3) *Weights and volumes.* A reference to the table on page 12 shows that the weight-numbers of potassium and sodium are respectively 39 and 23.

$$\begin{array}{rcccl} 2\,H^2O & + & 2\,K & = & 2\,KHO + H^2 \\ \underbrace{2\,(2+16)} & + & \underbrace{2\times 39} & = & \underbrace{2\,(39+1+16)} + 2 \\ 36 & + & 78 & = & 112 + 2 \text{ vols.} \end{array}$$

36 parts by weight (say grams) of water into which 78 parts by weight of potassium are plunged yield 112 parts by weight of potassium hydrate and 2 parts by weight, or 2 parts by volume, of hydrogen.

$$\begin{array}{rcccl} 2\,H^2O & + & 2\,Na & = & 2\,NaHO + H^2 \\ \underbrace{2\,(2+16)} & + & \underbrace{2\times 23} & = & \underbrace{2\,(23+1+16)} + 2 \\ 36 & + & 46 & = & 80 + 2 \text{ vols.} \end{array}$$

EXERCISES ON THE PREPARATION OF HYDROGEN FROM WATER AND POTASSIUM OR SODIUM (*Solved*).

(29) Required 1 gram hydrogen. What weight of water will be decomposed?

2 grams H yielded by 36 grams H^2O
1 gram ,, ,, ,, $\frac{36}{2}$,, ,,
18 grams.

(30) Upon a litre of distilled water a number of small pieces of sodium are thrown, weighing in all 2 kilograms. What weight of hydrogen is evolved, and what weight of water or of metal is left at the end of the experiment?

1 litre of water = 1000 cc. = 1000 grams.
36 grams H^2O need 46 grams Na and evolve 2 grams H
1 gram ,, needs $\frac{46}{36}$,, ,, ,, evolves $\frac{2}{36}$,, ,,
1000 grams ,, need $\frac{46\times 1000}{36}$,, ,, evolve $\frac{2\times 1000}{36}$,,
$1277\frac{7}{9}$ grams Na are required and
$55\frac{5}{9}$,, H ,, evolved.
$\therefore$ $2000 - 1277\frac{7}{9}$ grams Na are left.
$722\frac{2}{9}$ grams Na, $55\frac{5}{9}$ grams left H evolved.

(31) As result of throwing potassium on water $2\frac{1}{2}$ grams hydrogen are evolved. What weight of potash is formed?

2 grams H are evolved when 112 grams KHO are formed.
1 gram ,, is ,, ,, $\frac{112}{2}$,, ,, ,,
$\frac{5}{2}$ grams ,, are ,, ,, $\frac{112\times 5}{2\times 2}$,, ,, ,,
140 grams.

(*To be continued.*)

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'LITTLE LEARNER' FOR AUGUST, 1884.

STANDARD I.

(1) 2895
(2) 701
(3) 181
(4) 2849
(5) 293
(6) 195
(7) 803
(8) 90
(9) 483
(10) 2304
(11) 2699
(12) 5698
(13) 4239
(14) 244
(15) 92
(16) 3962
(17) 91
(18) 8
(19) 1738
(20) 591
(21) 698
(22) 3846
(23) 221
(24) 106
(25) 4265
(26) 95
(27) 357

STANDARD II.

A. 1. 376,721
2. 259,137
3. 191,852
B. 1. 29,384
2. 10,266
3. 13,033
C. 1. 511,101
2. 434,148
3. 628,271
D. 1. 1,387,020
2. 733,266
3. 7,120,036
E. 1. 69,566,280
2. 47,577,690
3. 108,831,400
F. 1. 2567
2. 6789+7
3. 4467+6
G. 1. 4,630+2
2. 8,252+8
3. 2,105+6
H. 1. 769+67
2. 550,817,000
3. 29,577,924
I. 1. 515,612,600
2. 197,102,950
3. 581,454,720

GRANDFATHER'S CLOCK.

T. CRAMPTON.

Moderato.
mf
1st TREBLE.
2nd TREBLE.
BASS.
1. It (1) stands in the cor - ner of grand-fa-ther's room, From the ceil-ing (2) it reach-es the floor; (3)
2. The clock nev - er sleeps and its hands nev - er rest, (5) As they slow-ly go mov-ing a - round;
KEY F. Moderato. mf
1st TREBLE.
2nd TREBLE.
BASS.
"Tick - tock!" it keeps say - ing the whole day long, "Tick - tock!" and no - thing more.
It strikes on the hours with a ding! (6) ding! ding! Ding! ding! a whir - ring sound.
C. t.
Back-wards (4) and for - wards, this way, and that, You can see the big pen - du - lum rock;
Is this, I won - der, the same old clock That the mous - ie ran (7) up in the night,
f. F.
"Tick - tock!" it keeps say - ing the whole day long, "Tick - tock! tick - tock! tick - tock!"
And played Hide and seek (8) till the clock struck ONE! And then ran down (9) with fright?
Symph. p
Symph. p

(1) Point to the corner of the room. (2) Point upwards. (3) Point downwards. (4) Swing the right hand and arm to and fro. (5) Move fingers slowly round. (6) Strike the desk with the right hand. (7) Move the hands upwards and the fingers quickly. (8) Hold both hands before the eyes. (9) Move hands downwards with fingers moving rapidly.

A BOY IS A BOY.

For Boys' Schools. T. CRAMPTON.

Jovially (2nd verse rather slower).
1st TREBLE.
2nd TREBLE.
BASS.
1. Re - mem-ber, a boy is a boy, not a man! Don't frown when your pa-tience he tries;
2. The eye that so oft - en is kin - dled with joy, At sor - row will melt in - to tears;
3. Dis - or - der may wait on the fro - lic and fun, And qui - e - tude fly at the noise;
KEY A. Jovially (2nd verse rather slower).
But bear with his fol - lies as well as you can, And hope he will learn to be wise.
For ten - der and warm is the heart of a boy, Tho' home - ly the coat that he wears.
But give not the man-dates from ty - ran - ny's throne, But go - vern with kind - ness the boys.
E. t.
CHORUS.
Yes, a boy is a boy, and a boy let him be, For the sea - son of
f. A. CHORUS.
boy - hood's a span; And the heart that now leaps in its glad - ness and glee, Soon will
ache with the cares of the man.
Symph.
Symph.

Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

Gold Medallist and University Scholar, Physician to the City Dispensary.

CHAPTER X.—THE BLOOD.

IN considering the circulatory system, it will be convenient to study first the blood and its properties; then the anatomy of the heart and blood-vessels; and, finally, the mechanism of the circulation.

The blood is a tissue which differs from other tissues in not being fixed to one part. It may be compared to cartilage, the cartilage-cells being represented by the blood-corpuscles, while the matrix of the cartilage has become fluid, thus allowing free movement of the corpuscles.

When blood is seen directly after its escape from the blood-vessels, it is a viscid opaque liquid, varying in colour from deep purple to bright scarlet, and having a distinct though slight odour, which varies in different animals. It gives an alkaline reaction to litmus paper, and has an average specific gravity in man of 1055 (water = 1000).

The *quantity of blood* is difficult to estimate. One of the most reliable methods of estimating it is to kill an animal, and rapidly empty its blood-vessels by bleeding it. Next wash out the vessels with water, and collect and mix the washings. A known quantity of blood is then diluted with water until it possesses the same tint as a measured specimen of the washings. From this the total amount of blood in all the washings can easily be estimated. Finally, the whole body is carefully minced up, and washed free from blood. The amount of blood in these washings is estimated as before. This, added to the amount calculated from the previous washings, and to the amount of escaped blood, gives the total quantity of blood in the body, which is generally found to be about $\frac{1}{13}$ of the body weight. Even in this method slight fallacies exist, but it may be taken as approximately correct.

Broadly, the *distribution of the blood* is as follows:—

About one-fourth in the heart, lungs, large arteries and veins,
" " " liver,
" " " muscles of the skeleton,
" " " other organs.

It is evident, therefore, that the most important changes in the blood must occur in the liver and the muscles.

If a drop of blood be examined microscopically immediately after its escape, it will be seen to consist of two parts—a *liquor sanguinis or plasma*, and *corpuscles*. When a quantity of blood escapes it soon begins to readjust its constituents. A new element which did not exist as such in blood is produced (*fibrin*), which entangles the blood corpuscles, and thus produces the *crassamentum* or clot.

Liquid blood { liquor sanguinis { serum / fibrin } / corpuscles . . . . . } clot.

The *corpuscles* of the blood are of two kinds, commonly known as red and white, the former being by far the most numerous. On an average there are from 400 to 500 red to one white corpuscle, though the proportion varies in different parts of the body. In the splenic vein, the proportion is about 70 to 1. At different parts of the day the proportion varies, the number of white corpuscles being increased by a meal.

The *white corpuscles* are not so regularly circular as the red. When seen under the microscope, they refract the light owing to the presence of a nucleus, which is rendered much more evident by the addition of a drop of acetic acid to the slide. They average $\frac{1}{2500}$ inch in diameter.

Their most remarkable property is that of assuming different shapes when watched under the microscope in blood serum which is kept at the temperature of the body. These amœboid movements are analogous to the movements exhibited by the amœba, to which reference has been previously made.

The *red corpuscles* are somewhat smaller than the white, averaging $\frac{1}{3200}$ inch in diameter. They are circular in outline when flat, but slightly biconcave when seen edgewise. When seen directly after withdrawal from the body they appear quite homogeneous, showing no cell-wall or nucleus. In colour they are pale yellow when seen singly, deep red when seen *en masse*.

They possess a great tendency to adhere together into rolls or columns (rouleaux), like piles of coins,

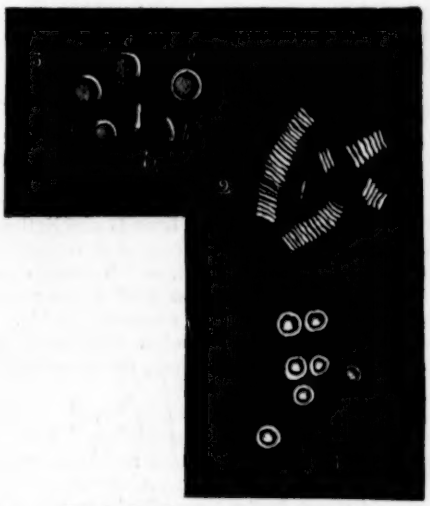


Fig. 41.—Red Corpuscles much magnified; (1) enclosed in meshes of fibrin during coagulation; (2) collected into rouleaux; (3) showing the biconcave discs, (*a*) flat, (*b*) edgewise.

and then these piles become clustered together in irregular masses. This aggregation of the corpuscles increases their specific gravity, and so makes them sink more rapidly in blood which is kept in a basin.

The red corpuscles are very short-lived. The slightest evaporation causes them to shrivel, assuming an indented or crenated edge. Oxygen gives them a sharper outline and brighter colour. Carbonic acid causes them to swell and become opaque towards the centre. By an induced electric current a fibrillated appearance is produced. When a solution of magenta is added to blood, the magenta becomes deposited towards the centre of the red corpuscles, which is probably less dense than their exterior. Boracic acid causes a distinct differentiation of the substance of the corpuscle.

Chemically considered, 100 parts of wet red corpuscles consist of 56·5 parts of water, and 43·5 of solid matter.

The inorganic material in the solids of corpuscles amounts to less than 1 per cent. It consists chiefly of potassium chloride and phosphate.

Of the organic matter of the corpuscles, hæmoglobin forms 90·5 per cent., other proteid substances 8·7, there being only minute quantities of the remaining substances, lecithin and cholesterin.

Hæmoglobin, when separated from the other constituents of red corpuscles, is readily soluble in water and in serum. This being so, it is evident that there must be in the blood some intimate combination between the stroma and the hæmoglobin of the corpuscles, which prevents the latter being washed away. In preparing hæmoglobin it is necessary to break up the corpuscles, by the addition of chloroform or by alternate freezing and thawing. An aqueous solution of hæmoglobin can then be obtained.

Hæmoglobin from the blood of the rat, horse, dog, and some other animals, crystallises readily in slender four-sided prisms. The crystals from the guinea-pig's blood are octahedral, those from the hedgehog are six-sided plates; while the blood of the ox, sheep, pig, and man crystallises with difficulty.

The most important property of hæmoglobin is its power of entering into a loose chemical combination with oxygen, forming *oxy-hæmoglobin*. This change is constantly occurring in the lungs, where the reduced hæmoglobin of venous blood is acted upon by the oxygen of the air in the pulmonary vesicles. The oxy-hæmoglobin is carried to the various tissues of the body, which rob it of its oxygen.

When a dilute solution of hæmoglobin is placed before a spectroscope, it absorbs certain rays of light in a characteristic manner. Two marked absorption bands appear between the solar lines D and E, the one towards the red side being narrower and darker than the one towards the blue side, which shades away more gradually. The position and appearance of these bands is a certain test for oxy-hæmoglobin.

The oxygen of oxy-hæmoglobin may be removed by exhaustion under an air-pump, or by a reducing agent, such as ammonic sulphide.

The reduced hæmoglobin differs spectroscopically in appearance from oxy-hæmoglobin. The two absorption bands have disappeared and been replaced by a single much broader band, intermediate in position. If the reduced hæmoglobin is exposed to air, it absorbs oxygen and reassumes the spectrum of oxy-hæmoglobin. The different colour of venous and arterial blood is due to the presence of a smaller amount of oxy-hæmoglobin in the former than the latter.

Hæmoglobin combines with other gases as well as oxygen, when exposed to their influence. Thus with carbonic oxide it forms a more stable compound than with oxygen. If a large number of red corpuscles form this compound (as occurs in poisoning by the fumes of burning charcoal) oxidation changes in the tissues are prevented, and poisoning rapidly occurs.

Although capable of crystallisation, hæmoglobin is but slightly diffusible. This is owing to its consisting in part of a proteid body (globin), which is associated with a coloured body (hæmatin). The proteid material is coagulated by heating a solution of hæmoglobin, hæmatin being liberated, which possesses a well-marked spectrum. Hæmatin is a dark brown powder, of which the composition is probably $C_{32}\ H_{34}\ N_4\ Fe\ O_5$. By the action of strong sulphuric acid, it is deprived of its iron, and is no longer capable of combining loosely with oxygen. The iron seems therefore closely associated with the respiratory function of hæmoglobin.

The red corpuscles are derived from white corpuscles, which are being constantly produced by multiplication from the leucocytes of lymphoid tissue all over the body. There can be little doubt that the nucleus of the white corpuscle breaks up and disappears, its protoplasm being converted into hæmoglobin and stroma. According to Wharton Jones and Huxley, however, the nucleus of the white corpuscle becomes the red corpuscle, the rest of it disappearing.

The red corpuscles have been already stated to be short-lived. They are being constantly formed from white corpuscles, in the spleen and elsewhere; while at the same time other red corpuscles become broken down and disintegrated. The spleen plays an active part in this change likewise. The ultimate destination of the derivatives of hæmoglobin is somewhat doubtful; but it seems certain that *hæmatoidin* crystals, which are commonly contained in old blood-clots and are a derivative of hæmoglobin, are identical with the bilirubin of bile. It seems probable that the urinary pigment has a similar origin, though the connection has not been traced.

Proof of the short-lived character of the red blood corpuscles is furnished by their varying number at different parts of the day, and by the fact that when the blood of one animal is injected into the veins of another, the foreign corpuscles soon disappear.

(To be continued.)

ANSWERS TO ARITHMETICAL QUESTIONS IN 'THE SCHOLAR' FOR AUGUST, 1884.

STANDARD III.

A. 1. 9443+12.
2. 15,504+36.
3. 20,085+45.

B. 1. 25,660+24.
2. 5513+42.
3. 1424+29.

C. 1. 7508+7.
2. 9012+49.
3. 14,395+148

D. 1. £256 12s. 1d.
2. £244 9s. 7½d.
3. £18,651 4s. 3½d.

E. 1. £49 10s. 2½d.
2. £6490 0s. 0½d.
3. £7 12s. 2½d.

STANDARD IV.

A. 1. £57 17s. 9½d.+49.
2. £305,309 17s. 3½d.
3. 1,000,000.

B. 1. 13,644.
2. £1 12s. 1½d.
3. £451 4s. 1½d.

C. 1. £196 13s. 8¾d.+17.
2. 141,283.
3. 897,120.

D. 1. £443 6s. 8d.
2. 2880.
3. £9 14s. 9½d.

E. 1. £5,669,579 10s. 1d.
2. £14 5s. 9d.
3. 200 times.

F. 1. 392.
2. 67,000 guineas.
3. £4 1s. 9½d.

STANDARD V.

A. 1. £36 3s. 6½d.
2. £3090 7s. 6d.
3. £6730 15s.

B. 1. $1\frac{308}{318}$.
2. £10 7s. 6d.
3. £5809 4s. 4½d.

C. 1. £24 5s. 9½d.
2. £329 3s. 4d.
3. 120 yds.

D. 1. $\frac{98}{198}$.
2. £3 1s. 6d.
3. 25.

E. 1. $1\frac{144}{144}$.
2. £11 4s. 5½d.
3. £7096 13s. 4d.

F. 1. £15 15s. 11¾d.
2. £412.899 4s. 6d.
3. £10 8s. 6½d.

STANDARD VI.

A. 1. $\frac{3}{4}$.
2. £24 18s. $4\frac{8}{17}$d.
3. $7\frac{3}{11}$.

B. 1. 3s. 6d.
2. ·1946428571.
3. (*a*) ·021015.
(*b*) 1250.

C. 1. 16 men.
2. 10 ozs. $10\frac{3}{5}$ drs.
3. 300 pages.

D. 1. ·142857.
2. £8,273,280.
3. 63 ft.

E. 1. $\frac{88}{990}$.
2. 5s.
3. £44 11s. $11\frac{3}{4}$d.
$\frac{33}{1000}$q.

STANDARD VII.

A. 1. (*a*) 2s. $2\frac{3}{4}$d.
(*b*) 1 cwt. 7 lb.
2. ·24.
3. £$1\frac{1}{3}\frac{1}{3}$ or £1 18s. $0\frac{4}{9}$d. p.c.

B. 1. £91.
2. $1\frac{9}{11}$.
3. ·95 or $\frac{19}{20}$.

C. 1. $30\frac{8}{13}\frac{0}{3}$.
2. 13 ozs.
3. £593 15s.

D. 1. Disc. £4 5s. $11\frac{3}{8}\frac{3}{0}$d.
Pres. Val. £245
14s. $0\frac{3}{4}\frac{3}{9}$d.
2. £16 12s. $4\frac{3}{4}\frac{3}{4}$d.
3. 900 p.c.

ANSWERS TO ALGEBRA QUESTIONS IN THE 'SCHOLAR' FOR AUGUST, 1884.

EXERCISE XXXIII.

(1) ± 4
(2) ± 7
(3) ± 2
(4) ± 3
(5) ± 4
(6) $\pm \frac{1}{2}$
(7) ± 5
(8) ± 1
(9) ± 5
(10) $\pm \sqrt{\frac{2}{3}}$
(11) $\pm \sqrt{31}$
(12) $\pm c$

ANSWERS TO Pupil Teachers' Examination Papers.

JUNE 28TH, 1884.

FIRST YEAR.

Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Simplify $\frac{3\frac{1}{3} - 2\frac{1}{2} \text{ of } \frac{7}{4} \div 3\frac{1}{7}}{6\frac{2}{3} \text{ of } 1\frac{3}{4} - \frac{5}{8}}$

$$= \frac{\frac{10}{3} - \frac{5}{2} \times \frac{7}{4} \div \frac{22}{7}}{\frac{20}{3} \times \frac{7}{4} - \frac{5}{8}}$$

$$= \frac{\frac{10}{3} - \frac{245}{112} \div \frac{154}{7}}{\frac{35}{2} - \frac{5}{8}}$$

$$= \frac{160 - 105}{48} \times \frac{24}{230 - 15} \times \frac{7}{154} = \frac{55}{48} \times \frac{24}{215} \times \frac{7}{154}$$

$$= \frac{7}{172}. \text{ Ans.}$$

2. What decimal of 15s. $7\frac{1}{2}$d. is equal to 13s. 6d.?

$$\frac{13\text{s. } 6\text{d.}}{15\text{s. } 7\frac{1}{2}\text{d.}} = \frac{162}{187\frac{1}{2}} = \cdot 864. \text{ Ans.}$$

3. Write down in order of magnitude (the greatest first), ·6, ·67, ·667, ·6649, ·665; and find the difference between ·6 and ·6649 without using vulgar fractions.

·67, ·667, ·6, ·665, ·6649. Ans.

·66666 + − ·66490 = ·00176. Ans.

4. A bankrupt's assets amounted to £3750, and his creditors lost $\frac{15}{16}$ of their money; what did the bankrupt's debts amount to?

$\frac{15}{16} - \frac{13}{16} = \frac{2}{16}$ frac. rep. assets.

£
$\frac{2}{16} = 3750$
$\frac{1}{16} = \frac{3750}{2}$
$\frac{15}{16} = \frac{3750 \times 16}{2}$
$= £20{,}000.$ Ans.

FEMALES.

1. Four bells toll at intervals of 3, 7, 12, and 14 seconds respectively, and begin to toll at the same instant; when will they next toll together?

They will toll together in as many secs. as are represented by the L.C.M of 3, 7, 12, and 14.

L.C.M. of 3, 7, 12, 14 = 84 secs. Ans.

2. What will it cost to drain 18 miles 6 fur. 30 poles at £7 19s. $11\frac{1}{2}$d. per mile?

	£	s.	d.		
4 f. = $\frac{1}{2}$ m.	7	19	$11\frac{1}{2}$	= Cost of 1 mile.	
	18				
	143	19	3	= ,,	18 miles.
2 f. = $\frac{1}{2}$ of 4 f.	3	19	$11\frac{1}{2}$	= ,,	4 fur.
20 p. = $\frac{1}{2}$ of 2 f.	1	19	$11\frac{1}{2}$	= ,,	2 fur.
10 p. = $\frac{1}{2}$ of 20 p.	0	9	$11\frac{1}{2}$	= ,,	20 poles.
	0	4	$11\frac{1}{2}$	= ,,	10 poles.
	£150	14	$2\frac{1}{2}$	= ,,	18 m. 6 f. 30 p.

3. Make out the following bill and properly receipt it:—

13½ yds. ribbon at 1s. 4½d. per yd.
47 yds. calico at 8½d. per yard.
2½ doz. pair gloves at 2s. 8d. per pair.
5 table cloths at a guinea and half each.
25 reels of cotton at 1½d. per reel.

London, June 28th, 1884.

Mrs. Jones,

Bought of Brown and Robinson.

	£	s.	d.
13½ yds. ribbon at 1s. 4½d. per yd.... ...	0	18	6¾
47 yds. calico at 8½d. per yd.	1	13	3½
2½ doz. pairs of gloves at 2s. 8d. per pair ...	4	0	0
5 table cloths at 1½ guineas each	7	17	6
25 reels cotton at 1½d. per reel	0	3	1½
	£14	12	5¾

Received £14 : 12 : 5¾
Same time
J. B. for Brown and Robinson.

4. What must be added to the sum of $7\frac{5}{2}\frac{0}{0}$, $12\frac{4}{1}\frac{5}{5}$, $4\frac{7}{1}\frac{2}{5}$, $\frac{8}{4}\frac{0}{0}$, and $3\frac{7}{1}\frac{0}{0}$ to make 30?

$$30 - (7\frac{5}{2}\frac{0}{0} + 12\frac{4}{1}\frac{5}{5} + 4\frac{7}{1}\frac{2}{5} + \frac{8}{4}\frac{0}{0} + 3\frac{7}{1}\frac{0}{0})$$

$$= 30 - 26\frac{54 + 32 + 70 + 27 + 84}{120}$$

$$= 30 - 28\frac{27}{120}$$

$$= 1\frac{93}{120}. \text{ Ans.}$$

Grammar.

MALES AND FEMALES.

1. 'I come, I come, ye have called me long;
I come o'er the mountains with light and song.'

(*a*) Say how many sentences there are in these two lines and distinguish the parts of each.

(*b*) Parse all the words in the passage.

(*a*) Four sentences:
(1) and (2) I, *subject*; come, *predicate*.
(3) Ye, *sub.*; have called, *pred.*; me, *obj.*; long, *ext. of pred.*
(4) I, *sub.*; come, *pred.*; o'er the mountains with light and song, *ext. of pred.*

(*b*) *I*—pers. pron., 1st pers., sing. no., com. gen., nom. case to *come*.
come—verb, irreg. intrans., act., ind., pres., sing., 1st per., agreeing with its nom. *I*.
The second and third *I come* are parsed in the same way.
Ye—pers. pron., 2nd pers., plur., com. gen., nom. to *have called*.
have—aux. verb to *called*, indicating perfect tense.
called—past part. of the verb *to call*.
have called—verb, reg. trans., act., ind., perf. 2nd., agreeing with its nom. *ye*.
me—pers. pron., 1st pers., sing., com., obj., gov. by *have called*.
long—adv. of time, qualifying *have called*.
o'er—prep., showing the relation between *mountains* and *come*.
the—distg. adj., limiting *mountains*.
mountains—com. noun, plur., neut., 3rd, obj., gov. by *o'er*.
with—prep., showing rel. between *light* and *come*.
light—com. noun, neut., sing., 3rd, obj. gov. by *with*.
and—cop. conj., joining the sentences 'I come with light,' and 'I come with song.'
song—com. noun, neut., sing., 3rd, obj., gov. by *with*.

The inorganic material in the solids of corpuscles amounts to less than 1 per cent. It consists chiefly of potassium chloride and phosphate.

Of the organic matter of the corpuscles, hæmoglobin forms 90·5 per cent., other proteid substances 8·7, there being only minute quantities of the remaining substances, lecithin and cholesterin.

Hæmoglobin, when separated from the other constituents of red corpuscles, is readily soluble in water and in serum. This being so, it is evident that there must be in the blood some intimate combination between the stroma and the hæmoglobin of the corpuscles, which prevents the latter being washed away. In preparing hæmoglobin it is necessary to break up the corpuscles, by the addition of chloroform or by alternate freezing and thawing. An aqueous solution of hæmoglobin can then be obtained.

Hæmoglobin from the blood of the rat, horse, dog, and some other animals, crystallises readily in slender four-sided prisms. The crystals from the guinea-pig's blood are octahedral, those from the hedgehog are six-sided plates; while the blood of the ox, sheep, pig, and man crystallises with difficulty.

The most important property of hæmoglobin is its power of entering into a loose chemical combination with oxygen, forming *oxy-hæmoglobin*. This change is constantly occurring in the lungs, where the reduced hæmoglobin of venous blood is acted upon by the oxygen of the air in the pulmonary vesicles. The oxy-hæmoglobin is carried to the various tissues of the body, which rob it of its oxygen.

When a dilute solution of hæmoglobin is placed before a spectroscope, it absorbs certain rays of light in a characteristic manner. Two marked absorption bands appear between the solar lines D and E, the one towards the red side being narrower and darker than the one towards the blue side, which shades away more gradually. The position and appearance of these bands is a certain test for oxy-hæmoglobin.

The oxygen of oxy-hæmoglobin may be removed by exhaustion under an air-pump, or by a reducing agent, such as ammonic sulphide.

The reduced hæmoglobin differs spectroscopically in appearance from oxy-hæmoglobin. The two absorption bands have disappeared and been replaced by a single much broader band, intermediate in position. If the reduced hæmoglobin is exposed to air, it absorbs oxygen and reassumes the spectrum of oxy-hæmoglobin. The different colour of venous and arterial blood is due to the presence of a smaller amount of oxy-hæmoglobin in the former than the latter.

Hæmoglobin combines with other gases as well as oxygen, when exposed to their influence. Thus with carbonic oxide it forms a more stable compound than with oxygen. If a large number of red corpuscles form this compound (as occurs in poisoning by the fumes of burning charcoal) oxidation changes in the tissues are prevented, and poisoning rapidly occurs.

Although capable of crystallisation, hæmoglobin is but slightly diffusible. This is owing to its consisting in part of a proteid body (globin), which is associated with a coloured body (hæmatin). The proteid material is coagulated by heating a solution of hæmoglobin, hæmatin being liberated, which possesses a well-marked spectrum. Hæmatin is a dark brown powder, of which the composition is probably $C_{32}\ H_{34}\ N_4\ Fe\ O_5$. By the action of strong sulphuric acid, it is deprived of its iron, and is no longer capable of combining loosely with oxygen. The iron seems therefore closely associated with the respiratory function of hæmoglobin.

The red corpuscles are derived from white corpuscles, which are being constantly produced by multiplication from the leucocytes of lymphoid tissue all over the body. There can be little doubt that the nucleus of the white corpuscle breaks up and disappears, its protoplasm being converted into hæmoglobin and stroma. According to Wharton Jones and Huxley, however, the nucleus of the white corpuscle becomes the red corpuscle, the rest of it disappearing.

The red corpuscles have been already stated to be short-lived. They are being constantly formed from white corpuscles, in the spleen and elsewhere; while at the same time other red corpuscles become broken down and disintegrated. The spleen plays an active part in this change likewise. The ultimate destination of the derivatives of hæmoglobin is somewhat doubtful; but it seems certain that *hæmatoidin* crystals, which are commonly contained in old blood-clots and are a derivative of hæmoglobin, are identical with the bilirubin of bile. It seems probable that the urinary pigment has a similar origin, though the connection has not been traced.

Proof of the short-lived character of the red blood corpuscles is furnished by their varying number at different parts of the day, and by the fact that when the blood of one animal is injected into the veins of another, the foreign corpuscles soon disappear.

(To be continued.)

ANSWERS TO ARITHMETICAL QUESTIONS IN 'THE SCHOLAR' FOR AUGUST, 1884.

STANDARD III.

A. 1. 9443+12.
2. 15,504+36.
3. 20,085+45.

B. 1. 25,660+24.
2. 5513+42.
3. 1424+29.

C. 1. 7508+7.
2. 9012+49.
3. 14,395+148

D. 1. £256 12s. 1d.
2. £244 9s. 7½d.
3. £18,651 4s. 3½d.

E. 1. £49 10s. 2½d.
2. £6490 0s. 0¾d.
3. £7 12s. 2¼d.

STANDARD IV.

A. 1. £57 17s. 9½d.+49.
2. £305,309 17s. 3½d.
3. 1,000,000.

B. 1. 13,644.
2. £1 12s. 1½d.
3. £451 4s. 1¾d.

C. 1. £196 13s. 8¾d.+17.
2. 141,283.
3. 897,120.

D. 1. £443 6s. 8d.
2. 2880.
3. £9 14s. 9½d.

E. 1. £5,669,579 10s. 1d.
2. £14 5s. 9d.
3. 200 times.

F. 1. 392.
2. 67,000 guineas.
3. £4 1s. 9½d.

STANDARD V.

A. 1. £36 3s. 6½d.
2. £3090 7s. 6d.
3. £6730 15s.

B. 1. $1\frac{8}{15}$.
2. £10 7s. 6d.
3. £5809 4s. 4½d.

C. 1. £24 5s. 9½d.
2. £329 3s. 4d.
3. 120 yds.

D. 1. $\frac{35}{48}$.
2. £3 1s. 6d.
3. 25.

E. 1. $1\frac{11}{12}$.
2. £11 4s. 5½d.
3. £7096 13s. 4d.

F. 1. £15 15s. 11¾d.
2. £412.899 4s. 6d.
3. £10 8s. 6½d.

STANDARD VI.

A. 1. $\frac{3}{5}$.
2. £24 18s. $4\frac{4}{11}$d.
3. $7\frac{1}{12}$.

B. 1. 3s. 6d.
2. ·1946428571.
3. (*a*) ·021015.
(*b*) 1250.

C. 1. 16 men.
2. 10 ozs. $10\frac{2}{3}$ drs.
3. 300 pages.

D. 1. ·142857.
2. £8,273,280.
3. 63 ft.

E. 1. $\frac{55}{176}$.
2. 5s.
3. £44 11s. 11¾d.
$\frac{31}{100}$q.

STANDARD VII.

A. 1. (*a*) 2s. $2\frac{3}{4}$d.
(*b*) 1 cwt. 7 lb.
2. ·24.
3. £$1\frac{1}{19}\frac{1}{19}$ or £1 18s. $0\frac{4}{19}$d. p.c.

B. 1. £91.
2. $1\frac{3}{11}$.
3. ·95 or $\frac{19}{20}$.

C. 1. $30\frac{8}{123}$.
2. 13 ozs.
3. £593 15s.

D. 1. Disc. £4 5s. $11\frac{3}{41}\frac{3}{41}$d. Pres. Val. £245 14s. $0\frac{3}{41}\frac{4}{41}$d.
2. £16 12s. $4\frac{3}{61}\frac{3}{61}$d.
3. 900 p.c.

ANSWERS TO ALGEBRA QUESTIONS IN THE 'SCHOLAR' FOR AUGUST, 1884.

EXERCISE XXXIII.

(1) ± 4
(2) ± 7
(3) ± 2
(4) ± 3
(5) ± 4
(6) $\pm \frac{1}{2}$
(7) ± 5
(8) ± 1
(9) ± 5
(10) $\pm \sqrt{\frac{11}{13}}$
(11) $\pm \sqrt{31}$
(12) $\pm c$

ANSWERS TO Pupil Teachers' Examination Papers.

JUNE 28TH, 1884.

FIRST YEAR.

Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Simplify $\frac{3\frac{1}{3} - 2\frac{1}{4} \text{ of } \frac{7}{8}}{6\frac{2}{3} \text{ of } 1\frac{3}{4} - \frac{1}{8}} \div \frac{3\frac{1}{2}}{5\frac{5}{8}}$

$$= \frac{\frac{10}{3} - \frac{9}{8} \times \frac{7}{8}}{\frac{20}{3} \times \frac{7}{4} - \frac{1}{8}} \div \frac{\frac{7}{2}}{\frac{45}{8}}$$

$$= \frac{\frac{10}{3} - \frac{63}{64}}{\frac{35}{3} - \frac{1}{8}} \div \frac{7}{10}$$

$$= \frac{160 - 105}{48} \times \frac{24}{230 - 15} \times \frac{10}{7} = \frac{55}{48} \times \frac{24}{215} \times \frac{10}{7}$$

$$= \underline{\frac{11}{28}}. \text{ Ans.}$$

2. What decimal of 15s. $7\frac{1}{2}$d. is equal to 13s. 6d.?

$$\frac{13\text{s. } 6\text{d.}}{15\text{s. } 7\frac{1}{2}\text{d.}} = \frac{162}{187} = \underline{\cdot 864}. \text{ Ans.}$$

3. Write down in order of magnitude (the greatest first), ·6, ·67, ·667, ·6649, ·665; and find the difference between ·6 and ·6649 without using vulgar fractions.

$$\underline{\cdot 67, \cdot 667, \cdot 6, \cdot 665, \cdot 6649.} \text{ Ans.}$$

$$\cdot 66666 + - \cdot 66490 = \underline{\cdot 00176}. \text{ Ans.}$$

4. A bankrupt's assets amounted to £3750, and his creditors lost $\frac{15}{16}$ of their money; what did the bankrupt's debts amount to?

$\frac{15}{16} - \frac{1}{16} = \frac{14}{16}$ frac. rep. assets.

£
$\frac{1}{16} = 3750$
$\frac{1}{16} = \frac{3750}{14}$
$\frac{16}{16} = \frac{3750 \times 16}{3}$
$= \underline{£20{,}000}.$ Ans.

FEMALES.

1. Four bells toll at intervals of 3, 7, 12, and 14 seconds respectively, and begin to toll at the same instant; when will they next toll together?

They will toll together in as many secs. as are represented by the L.C.M of 3, 7, 12, and 14.

secs.
L.C.M. of 3, 7, 12, 14 = $\underline{84}$. Ans.

2. What will it cost to drain 18 miles 6 fur. 30 poles at £7 19s. $11\frac{1}{2}$d. per mile?

	£	s.	d.		
4 f. = $\frac{1}{2}$ m.	7	19	$11\frac{1}{2}$	= Cost of 1 mile.	
		18			
	143	19	3	= ,,	18 miles.
2 f. = $\frac{1}{2}$ of 4 f.	3	19	$11\frac{3}{4}$	= ,,	4 fur.
20 p. = $\frac{1}{4}$ of 2 f.	1	19	$11\frac{3}{4}$	= ,,	2 fur.
10 p. = $\frac{1}{2}$ of 20 p.	0	9	$11\frac{13}{16}$	= ,,	20 poles.
	0	4	$11\frac{29}{32}$	= ,,	10 poles.
	£150	14	$2\frac{1}{32}$	= ,,	18 m. 6 f. 30 p.

3. Make out the following bill and properly receipt it:—

13⅓ yds. ribbon at 1s. 4½d. per yd.
47 yds. calico at 8½d. per yard.
2½ doz. pair gloves at 2s. 8d. per pair.
5 table cloths at a guinea and half each.
25 reels of cotton at 1½d. per reel.

London, June 28th, 1884.

Mrs. Jones,

Bought of Brown and Robinson.

	£	s.	d.
13⅓ yds. ribbon at 1s. 4½d. per yd.... ...	0	18	$6\frac{2}{3}$
47 yds. calico at 8½d. per yd.	1	13	$3\frac{1}{2}$
2½ doz. pairs of gloves at 2s. 8d. per pair ...	4	0	0
5 table cloths at 1½ guineas each	7	17	6
25 reels cotton at 1½d. per reel	0	3	$1\frac{1}{2}$
	£14	12	$5\frac{2}{3}$

Received £14 : 12 : $5\frac{2}{3}$
Same time
J. B. for Brown and Robinson.

4. What must be added to the sum of $7\frac{8}{15}$, $12\frac{4}{15}$, $4\frac{7}{15}$, $\frac{8}{15}$, and $3\frac{7}{15}$ to make 30?

$$30 - (7\frac{8}{15} + 12\frac{4}{15} + 4\frac{7}{15} + \frac{8}{15} + 3\frac{7}{15})$$

$$= 30 - 26\frac{54 + 32 + 70 + 27 + 84}{120}$$

$$= 30 - 28\frac{267}{120}$$

$$= \underline{1\frac{13}{40}}. \text{ Ans.}$$

Grammar.

MALES AND FEMALES.

1. 'I come, I come, ye have called me long;
I come o'er the mountains with light and song.'

(*a*) Say how many sentences there are in these two lines and distinguish the parts of each.

(*b*) Parse all the words in the passage.

(*a*) Four sentences:
(1) and (2) I, *subject*; come, *predicate*.
(3) Ye, *sub.*; have called, *pred.*; me, *obj.*; long, *ext. of pred.*
(4) I, *sub.*; come, *pred.*; o'er the mountains with light and song, *ext. of pred.*

(*b*) *I*—pers. pron., 1st pers., sing. no., com. gen., nom. case to *come*.
come—verb, irreg. intrans., act., ind., pres., sing., 1st per., agreeing with its nom. *I*.
The second and third *I come* are parsed in the same way.
Ye—pers. pron., 2nd pers., plur., com. gen., nom. to *have called*.
have—aux. verb to *called*, indicating perfect tense.
called—past part. of the verb *to call*.
have called—verb, reg. trans., act., ind., perf. 2nd., agreeing with its nom. *ye*.
me—pers. pron., 1st pers., sing., com., obj., gov. by *have called*.
long—adv. of time, qualifying *have called*.
o'er—prep., showing the relation between *mountains* and *come*.
the—distg. adj., limiting *mountains*.
mountains—com. noun, plur., neut., 3rd, obj., gov. by *o'er*.
with—prep., showing rel. between *light* and *come*.
light—com. noun, neut., sing., 3rd, obj. gov. by *with*.
and—cop. conj., joining the sentences 'I come with light,' and 'I come with song.'
song—com. noun, neut., sing., 3rd, obj., gov. by *with*.

2. Explain the meaning and use of the termination *en* in each of the following words, and give other words illustrating the same formation :—

Ox*en*. Drunk*en*. Earth*en*. Hard*en*.

Oxen—en is the plural termination in a few English words. In this case it forms the plural of ox. Other words: child, children; brother, brethren.

Drunken—en is the affix which forms the passive participle of several irregular verbs. It means *made*. Other words: speak, spoke, spoken; choose, chose, chosen.

Earthen—en means *made of*. It forms an adj. from a noun. Other exs.: wood, wooden; gold, golden.

Harden—en means *to make*. It forms a verb from an adj. Other words: soft, soften; weak, weaken.

Geography.

(*Answer either* Q. 1 *or* Q. 2, *not both.*)

1. Draw a map of Australia, inserting the lines of latitude and longitude.

2. Show from the hill system of the British Isles that the most beautiful scenery is to be found where the older rocks exist.

The most beautiful scenery of the British Isles may perhaps be said to be among the Western Highlands of Scotland, in Cumberland and Westmoreland, in N. Wales, and in the Western Highlands of Ireland. These hills are composed principally of granite, felspar, quartz, mica, and hornblende, which geologists class among the oldest or primary rocks. Usually such hills are bleak and barren, but the action of snow, wind, water, and sun has in many places filled the valleys or the sides of the hills with soil which is capable of cultivation or fit for the growth of trees, and there is in these districts a combination of mountain, hill, dale, lake, stream, and waterfall, rendering them the most beautiful in the country.

3. Enumerate the chief rivers of Scotland, and give a particular description of the course of one of them.

The principal rivers of Scotland are the Tweed, Forth, Tay, N. and S. Esk, Dee, Don, Spey, Ness, and Shin, running into the North Sea, the Annan, Nith, Dee, and Esk into the Solway Firth; the Clyde, Irvine, and Ayr, into the Firth of Clyde.

The Clyde is one of the most important rivers of Scotland. It rises in the Lowther Hills in the S. of Lanarkshire and flows in a north-westerly direction through the whole of that county. Its course is then almost due W., and by a wide estuary after a course of ninety-eight miles it empties itself into the Firth of Clyde. After leaving Lanark it separates the counties of Dumbarton and Renfrew. On its banks are Lanark (noted as the centre of the coal and iron district of the county, and near which are the Falls of Clyde, 100 feet in height), Glasgow (the largest town of Scotland), and Greenock (noted for shipbuilding).

4. Give a brief description of the West Coast of Ireland.

The W. coast of Ireland is exposed to the full force of the Atlantic waves and currents, and very much indented, resembling in a remarkable degree the coast of Norway. Its chief openings are Donegal, Sligo Killala, Clew, and Galway Bays, the mouth of the Shannon, Dingle, Kenmare, and Bantry Bays, besides many others. There are numerous islands and rocky islets, the chief being Aran, Achil, Clare, South Aran, and Valentia. The coast is high and rocky, in many places reaching from 1,000 to 2,000 feet. The indentations form good harbours, which are made use of by the fishing population of the W. coast.

5. Describe the position of Quebec, Ottawa, Halifax (N.S.), and give a brief account of the industries of Canada.

Quebec is situated on the N. bank of the river St. Lawrence, about 340 miles from its mouth. It is in the province of Quebec, in the Dominion of Canada, and is built on a promontory which stretches into the river.

Ottawa is at the junction of the Rideau Canal with the river Ottawa, and about 110 miles from the junction of the latter with the St. Lawrence.

Halifax, Nova Scotia, is on the S.E. coast of that province, in lat. 44° N. and long. 64° W. It has an extensive harbour.

Canada is a comparatively new country. Its chief industries are connected with the cultivation of the soil. It produces and exports timber, corn, hemp, wheat, and flour. Its seas in the east supply us with large quantities of fish, including cod, salmon, and lobster. Mines of coal, iron, copper, and lead are wrought in the eastern part of the Dominion, and gold is found in Columbia.

History.

1. What is known about the institutions and employments of the ancient Britons?

The Britons were under monarchical government, being divided into distinct tribes, some of which were known to the Romans as Cantii, Trinobantes, Iceni, and Bibroci. Their religion was Druidism, and consisted in worshipping a plurality of gods, the veneration of the oak and mistletoe, and human sacrifices. Charity towards man and fortitude in suffering were inculcated. Bards sang the praises of their princes, and accompanied their songs with music on an instrument called the Chrotta. The people in the south cultivated their land and exported some of their produce. Mines of copper and tin were also worked. The people of the north were shepherds and herdsmen. They were all trained to bear arms, which consisted of javelin, shield, and sword. Their war-chariots were low and easily mounted. They had no fortified towns, but surrounded their villages with a stockade and moat.

2. What made it necessary for Alfred the Great to establish a fleet?

The incursions of the Danes were so sudden, their training so warlike, and their boldness so great, that Alfred saw clearly if they were to be met they must be attacked not after, but before they reached the shores of this country. To guard, therefore, against future incursions of the Norsemen, Alfred tried to revive the old seafaring spirit of his countrymen, building ships which should be able to encounter the attacks of those of the Vikings of the north, and prevent the devastation of his land in the future.

3. When and how did England first fall under the rule of foreign kings?

The name *England* was not given to this country till the reign of Egbert or Athelstane. The first *foreign* kings who reigned over this country were therefore Sweyn and Canute, Kings of Norway, Denmark, and Sweden. Ethelred the Unready, instead of meeting the Danes as his predecessors had done, endeavoured to buy off their hostility with money, and levied *Danegeld* for that purpose. It succeeded for a time, but incursions became more frequent, and Sweyn, in 1013, made himself master of the country, and reigned for twelve months. He was succeeded by his son Canute.

Composition.

Write from memory the substance of the passage read to you by the Inspector.

It is in the Silver Spring region of Florida that the alligator flourishes, coming out to sun himself at midday on the logs and warm banks at the edge of the river. The alligator is a coward, rarely attacking even the smallest child unless the retreat to water in which to hide himself is cut off. These reptiles are hatched from eggs, which the female deposits in large numbers during the spring in muddy places, where she digs out a spacious cavity, fills it with several hundred eggs, and, thickly covering them with mud, leaves nature to do the rest. After a long incubation the little fellows come out, and make a straight cut for the nearest water. The big alligators who happen to be near make many a toothsome breakfast on the newly-born little ones.

Needlework.

FEMALES.

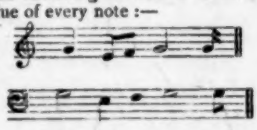
One hour will be allowed for this exercise in the afternoon.

Music.

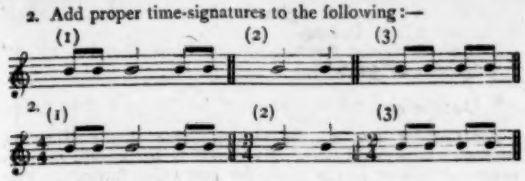
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Re-write the following an octave lower on the bass clef, doubling the value of every note :—

1. 

2. Add proper time-signatures to the following:—



3. Write below each of the following intervals its name (major fourth, &c.):—

TONIC SOL-FA NOTATION.

1. Write (1) the signs for three-pulse measure; and (2) the signs for four-pulse measure.

1. (1) | : : ‖ (2) | : | : ‖

2. Write the names of the following intervals:—(1) *me* to *fah*; (2) *soh* to *doh*^{1}; (3) *soh* to *me*^{1}; (4) *me* to *soh*.

2. (1) Minor 2nd; (2) Major or Perfect 4th; (3) Major 6th; (4) Minor 3rd.

3. Write the following an octave lower, and state what is meant by the direction "Key F":—

s m f l s d^1 r f l t d^1

3. s_1 m_1 f_1 l_1 s_1 d r_1 f_1 l_1 t_1 d

By "Key F" is meant that the sound F—the fourth note of the scale of C—is to be called *doh*, and is to be the tonic of the new scale.

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

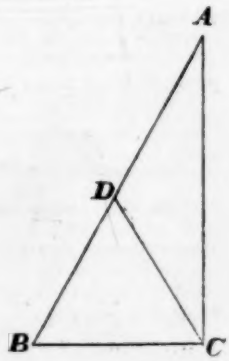
1. The angles at the base of an isosceles triangle are equal to each other; and if the equal sides be produced, the angles on the other side of the base shall be equal.

Euclid, Book I., Prop. 5.

2. If two straight lines cut one another, the vertical or opposite angles shall be equal.

Euclid, Book I., Prop. 15.

3. If a right-angled triangle have one of the acute angles double of the other, the hypotenuse shall be double of the side opposite to the smallest angle.



Let ACB be a right-angled triangle, having the acute ∠ at B double the acute ∠ at A.

Then the side AB is double the side BC.

At the point C make the ∠ ACD = ∠ CAD.

∴ (I. 6) AD = DC.

But ACD is a right ∠ (Hyp.) ∴ CBA, BAC = one right ∠ (I. 32). And ABC is double BAC, and is $\frac{2}{3}$ right ∠, ∴ DCB is $\frac{2}{3}$ right ∠ and = DBC. And (by I. 32) BDC also = $\frac{2}{3}$ right ∠, and the △ DBC is equilateral, ∴ DB = DC or BC. But DA also = DC, *i.e.* BC.

∴ BD, DA are each = BC, *i.e.* BA is double BC.

Arithmetic.

FEMALES.

1. Find the value of $\frac{3}{4}$ of a guinea + $1\frac{1}{2}$ of a crown + $\frac{2}{3}$ of 7s. 6d. − $\frac{3}{4}$ of 2d.

		s.	d.
$\frac{3}{4}$ gui.	$= \frac{3}{4} \times \frac{21}{1} = \frac{63}{4}$s.	= 0	15 9
$1\frac{1}{2}$ cr.	$= \frac{3}{2} \times \frac{5}{1} = \frac{15}{2}$s.	= 0	6 $10\frac{1}{2}$
$\frac{2}{3}$ of 7s 6d.	$= \frac{2}{3} \times \frac{15}{2} = \frac{5}{1}$s.	= 0	4 6
		£1	7 $1\frac{1}{2}$
$\frac{3}{4}$ of 2d.	$= \frac{3}{2}$d.	=	$1\frac{1}{2}$
		£1	7 0 Ans.

2. What weight is the same fraction of 15 cwt. 2 qrs. 13 lbs. that £1 11s. $10\frac{1}{2}$d. is of £3 10s. $1\frac{1}{2}$d.?

£1 11s. $10\frac{1}{2}$d. = $31\frac{1}{2}$s. = $\frac{63}{70}$ = $\frac{9}{10}$

£3 10s. $1\frac{1}{2}$d. = $70\frac{1}{2}$s.

$\frac{9}{10}$ of 15 cwt. 2 qrs. 13 lbs.

= $\frac{9}{10}$ of 1749 lbs.

= 795 lbs. or 7 cwt. 11 lbs. Ans.

3. By how much does $3\frac{1}{4} + 9\frac{1}{8} - 5\frac{1}{2}$ fall short of $8\frac{7}{16}$ of $2\frac{7}{19}$?

$(8\frac{7}{16}$ of $2\frac{7}{19}) - (3\frac{1}{4} + 9\frac{1}{8} - 5\frac{1}{2})$

$= (\frac{135}{16} \times \frac{45}{19}) - \left(7\frac{180+175-252}{315}\right)$

$= \frac{6075}{304} - 7\frac{103}{315}$

$= 19\frac{299}{304} - 7\frac{103}{315}$

$= 12\frac{94185 - 31312}{95760}$

$= 12\frac{62873}{95760}$. Ans.

4. Convert $\frac{1\frac{1}{16}}{5\frac{2}{7}}$ into a decimal.

$1\frac{1}{16} \div 5\frac{2}{7}$

$= \frac{17}{16} \times \frac{7}{37}$

$= \frac{3}{16}$

$= .1875$. Ans.

Grammar.

MALES AND FEMALES.

1. Analyse these lines, showing how many separate sentences they contain, and how each sentence is related to the other.

'The rainbow comes and *goes*,
And *lovely is* the rose;
The moon *doth* with delight
Look round her when the heavens are bare.'

2. Parse the words printed in italics.

1. ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Pred.	Object.	Extension.
(1) The rainbow comes	Princ. Sent.		The rainbow	comes		
(2) and goes,	P.S. co-ord. with (1)	and	[it]	goes		
(3) And lovely is the rose;	P.S. co-ord. with (1)	and	the rose	is lovely		
(4) The moon doth with delight look round her	Princ. Sent.		the moon	doth look		round her (*place*) with delight (*manner*)
(5) When the heavens are bare.	Adv. sent. to (4)	when	the heavens	are bare		

2. PARSING.

Goes—irreg. int. verb, act., ind., pres., sing., 3rd, agreeing with *it* understood.
lovely—adj. of quality, qual. *rose*.
is—irreg. intrans. verb, act., ind., pres., 3rd, sing., agreeing with *rose*.
doth—aux. verb to *look*, indicating pres. tense.
look—reg. intrans. verb, inf., pres., gov. by *doth*.
doth look—reg. intrans. verb, act., ind., pres., sing., 3rd, agreeing with *rose*.
round—prep., showing the relation between *her* and *doth look*.
her—per. pro., fem., sing., 3rd, obj., gov. by *round*.
when—advl. conj., joining the two sents.—'The moon doth look' and 'The heavens are bare.'

3. Make sentences in which the predicate shall consist :—
(1) Of the verb to be and a noun.
(2) Of the verb to be and an adjective.
(3) Of the verb to be and a participle.
(4) Of the verb to be and a phrase.

(1) My father *was a farmer*.
(2) Salt *is good*.
(3) Summer *is departing*.
(4) He *is of the greatest use to me*.

4. What is the difference in meaning between the syllable *im* at the beginning of an adjective, and the same syllable at the beginning of a verb? Compare *im*proper and *im*pose; and give other examples.

Im before an adjective means *not*; when used with a verb it means *in*, *into*, or *upon*, or *to make*.
Improper means *not proper*.
Impose means *to put upon*, or *to place upon*.
Other examples: With adj., impracticable, imprudent, improvident, immature, impartial, impenitent, impossible.
With verb: impair, improve, immerge, immerse, immigrate, imbrue.

Geography.

(*Answer either Q. 2 or Q. 3, not both.*)

1. Define latitude; name some of the towns in Europe in the same latitude with London, and compare the longitude and latitude of Edinburgh and Liverpool.

Latitude is distance north or south from the equator. Places north of the equator are said to be in N. lat.; places south of the equator in S. lat.

Rotterdam, Berlin (nearly), Warsaw, Brest.

Edinburgh is in a higher latitude than Liverpool, being in 55° 57′ N. lat., while Liverpool is in 53° 25′. They are nearly in the same long., Edinburgh being 3° 12′, and Liverpool 2° 59′ W. long.

2. Draw a map of Hindostan.

3. Enumerate the principal British possessions which lie within the tropics, and their chief productions.

The chief British possessions in the tropics are :—

S. India, including Ceylon, producing cotton, coffee, opium, indigo, sugar, jute, pepper, spices, oils, pearls, woods, and fruits.

Western Africa, producing palm oil, gold dust, ivory, teak, ground-nuts, gum, and beeswax.

West Indies, producing sugar, coffee, cocoa, cotton, indigo, arrowroot, ginger, dyewoods, fruits, and maize.

And *Queensland*, producing sugar, cotton, fruits, wool, and hides.

4. Describe the positions of Cadiz, Hamburgh, Antwerp, Odessa, Athens, and Vienna.

Cadiz, on the isle of Leon, in the extreme S.W. of Spain, a few miles N. of Cape Trafalgar. 36° 30′ N. lat., 6° 18′ W. long.

Hamburgh, about 70 miles from the mouth of the river Elbe, 53° 30′ N. lat. 10° E. long.

Antwerp, on the Schelde, in the N. of Belgium, situated in lat. 51° 30′ N., and long. 4° 30′ E.

Odessa, on the Black Sea, in the S. of Russia, between the mouths of the Dnieper and the Dniester, 47° N. lat., and 5e° E. long.

Athens, on the Gulf of Egina, in the S. of Greece, about 38° N. lat. and 23° 50′ E. long.

Vienna, in Lower Austria, on the River Danube, 16° 50′ E. long., and 46° 50′ N. lat.

5. Describe in words the courses of the Ganges and the Indus.

The Ganges rises on the northern side of the Himalaya mountains in a large cave. Its course is southward, through transverse valleys in the chain for 200 miles, having in that distance made a descent of nearly 10,000 feet. As it enters the plain of India at Hurdwar it is only some 1,000 feet above the level of the sea. Its course is now S.E. to Allahabad (500 m.), then E. for 500 miles. At the Rajmadal Hills it turns S., and enters the sea by many mouths, forming a large low delta, after a total course of 1,500 miles. It receives the Jumna at Allahabad, and the Sone, which rises in the Vindhya hills, on its right bank, and on its left bank the Goomtee, Gogra, and Gunduck.

The Indus also rises in the Himalayas at a greater height than the Ganges. After a course of 900 miles in a S.W. direction, it reaches the plain of India, and then flows S. for 900 miles more. It receives the Cabul river from Afghanistan on the right, and the Chenab, with Ravee, Jhelum, and Sutlej on the left. These five streams drain the district, called from them the Punjaub.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. Find the simple interest on £750 12s. 6d. from March 10th to August 3rd at 4½ per cent. per annum.

From March 10th to August 3rd is 146 days.

£ £ £ £
100 : 750½ :: 4½ : *x* Int.
365 : 146
$= \frac{6001}{2} \times \frac{149}{365} \times \frac{9}{2} \times \frac{1}{100} \times \frac{1}{100}$
$= \underline{£13\ 10s.\ 2{\cdot}7d.}$ Ans.

2. Find the average in the form of a decimal of ·6, ·67, ·659, ·1, and 0; and find the difference between this average and the greatest of the given quantities.

$(\cdot66666 + \cdot67 + \cdot659 + \cdot1 + 0) \div 5.$
$= \underline{\cdot4191\dot{3}}$. Ans.

Diff. between greatest and average
$= \cdot67 - \cdot4191\dot{3}$
$= \underline{\cdot25086}$. Ans.

3. If I invest money in 4½ per cent. railway debentures at 134⅞, what interest per cent. shall I get, the broker's charge being 2s. 6d. for each £100 of debentures bought?

Price paid $= 134\frac{7}{8} + \frac{1}{2} = 135.$
Int. on $135 = 4\frac{1}{2}$
,, $1 = \frac{4\frac{1}{2}}{135}$
,, $100 = \frac{4\frac{1}{2} \times 100}{135}$
$= \underline{3\frac{1}{3}}$. Ans.

4. A dealer by selling a horse for £3 more than he paid for it, gained 6¼ per cent.; what did he pay for the horse?

£
Principal to gain £$6\frac{1}{4} = 100$
,, ,, $1 = \frac{100}{6\frac{1}{4}}$
,, ,, £$3 = \frac{100 \times 3}{6\frac{1}{4}}$
$= \underline{£48}$. Ans

History.

MALES AND FEMALES.

1. The eldest sons of William I., Henry I., Stephen, Henry II., Edward III., Henry VI., and Richard III. did not come to the English throne; tell briefly the fate of those princes.

The eldest son of William I. was Robert. He became Duke of Normandy, joined the Crusades, was taken prisoner by his brother Henry, and after an imprisonment of twenty-seven years died, blind, in Cardiff Castle.

Henry I's. son William was drowned while crossing the Channel from France to England, in 1120.

Stephen's son Eustace on being excluded by treaty from the throne raised a rebellion near St. Edmundsbury, at which place he died in a frenzy when sitting down to a banquet.

The eldest son of Henry II. died in 1156, two years after his father ascended the throne.

The Black Prince, eldest son of Edward III., after taking part in the wars with France, joined Pedro the Cruel, but returned from Spain disabled by sickness, and died in 1376.

Edward, the son of Henry VI., was stabbed by the Dukes of Clarence and Gloucester at Tewkesbury, because he asserted his right to the throne of his father.

Richard III.'s eldest and only son died in 1484.

2. What was Edward III.'s claim to the throne of France? What resulted from the attempts to establish that claim?

Edward III.'s claim to the throne of France was founded on his descent from Philip III.; from whom also the reigning king claimed his descent. Edward's claim was through his mother, daughter of Philip IV. The Salic law, however, precluded females from reigning, and as Philip VI. was the nephew of Philip IV., through his brother Charles of Valois, Edward's claim was untenable.

From Edward's attempts to establish his claim came the wars with France for nearly a century, but in his reign alone there were the battles of Crecy and Poictiers, the siege of Calais, and the defeat and capture of the French king, ending in the peace of Bretigni, in 1360.

3. What occasioned the Wars of the Roses, and how did they end?

The Wars of the Roses were occasioned by the rival claims of the Houses of Lancaster and York to the throne of England. On the deposition of Richard II., grandson of Edward III., the crown went to the descendants of John of Gaunt, Duke of Lancaster, Edward's fourth son, passing over the claims of the descendants of Lionel, the third son. Henry VI.'s incapacity opened the way for a revival of the claims of these descendants, now merged in the family of York, and the prosecution of these claims caused the Wars of the Roses. They ended when Henry VII. was crowned on the battle-field. His marriage with Elizabeth, the heiress of the house of York, still further strengthened his title.

Teaching.

What is meant by *proving* the answer to a sum? Give the rule for proving in subtraction, and show how you would explain and illustrate it to a class.

By proving the answer to a sum is meant the arrival at the same result by another method, or if the process be reversed the obtaining of the numbers with which we started.

To prove a subtraction sum add the less number to the remainder; if this sum equals the larger number, then the subtraction will have been performed correctly.

Example: Take 64 from 81.

Perform the subtraction on the blackboard, and the remainder will be 17. Now 17 is the number by which 81 exceeds, or is larger than 64. Therefore, 64 and 17 together should equal 81 if the subtraction has been done correctly. Add them together, and the result is 81. The subtraction is, therefore, correct.

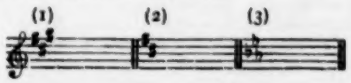
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

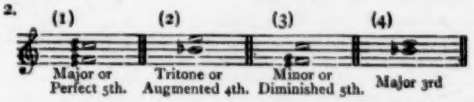
1. Write the key-signatures of each of the following major keys:—(1) of A; (2) of D; (3) of E♭.

1.

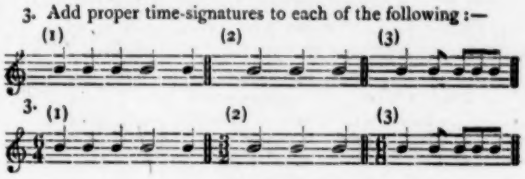


2. Write below each of the following intervals its name (major second, &c.):—

2.



3. Add proper time-signatures to each of the following:—



TONIC SOL-FA NOTATION.

1. Write the names of the following intervals:—(1) *lah*, to *me*; (2) *fah* to *te*; (3) *te*, to *fah*; (4) *doh* to *me*.

1. (1) Perfect 5th; (2) Pluperfect 4th or Tritone; (3) Minor or Imperfect 5th; (4) Major 3rd.

2. Which tones of the scale have the strongest leaning endency?

2. *Fah*, *te*, and *ray*.

3. Write (1) a three-pulse measure; (2) a four-pulse measure; and (3) a six-pulse measure.

3. (1) | : : ‖ (2) | : | : ‖ (3) | : : | : : |

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can.

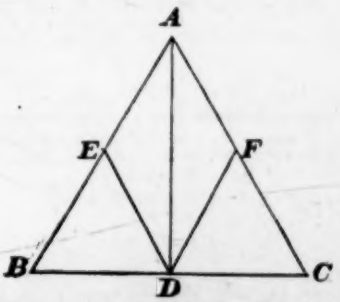
1. The straight lines which join the extremities of two equal and parallel straight lines towards the same parts are also themselves equal and parallel.

Euclid, Book I., Prop. 33.

2. If the square described upon one of the sides of a triangle be equal to the squares described upon the other two sides of it, the angle contained by these two sides is a right angle.

Euclid, Book I., Prop. 48.

3. In the base of a triangle find a point from which lines drawn to each side of the triangle, parallel to the other side, shall be equal.



Let ABC be a △. It is required to find a point in base BC, from which if lines be drawn parallel to the opposite sides they shall be equal to one another.

Bisect ∠ BAC by straight line AD, meeting BC in D. From D draw DF, DE parallel to AB, AC respectively. Join EF.

Then DF = DE.

∵ AF is parallel to ED and AD meets them. ∠ FAD = ∠ EDA. ∵ EA is parallel to FD and AD meets them, ∠ EAD = ∠ ADF.

But ∠ EAD = ∠ FAD (Const.) ∴ Each of the four ∠'s = one another. ∴ (I. 6) EA = ED and AF = FD. And ∵ AE is parallel to DF and AF to ED. ∴ AEDF is a parallelogram, and AE = DF. But AE = ED. ∴ ED = DF.

Wherefore D is the point required.

Q. E. F.

Algebra.

(Answer two Questions, including Question 2, if you can.)

1. Dividend is $6a^3 - 7a^2b + 8ab^2 - 9b^3$, the quotient is $2a - 5b$, and there is a remainder $2b^2(9a + 8b)$. Find the divisor.

$$2b^2(9a+8b) = 18ab^2 + 16b^3$$

$$\begin{array}{r|l} 2a - 5b & 6a^3 - 7a^2b + 8ab^2 - 9b^3 \\ & 6a^3 - 15a^2b \\ \hline & 8a^2b - 10ab^2 \\ & 8a^2b - 20ab^2 \\ \hline & 10ab^2 - 25b^3 \\ & 10ab^2 - 25b^3 \end{array} \quad 3a^2 + 4ab + 5b^2.$$

2. Let A and B represent two expressions, arranged according to descending (or ascending) powers of some common letter, and let B be of not higher dimensions than A. Divide A by B; let p be the quotient, and C the remainder. Divide B by C; let q be the quotient, and let there be no remainder. Prove that C is the greatest common measure of A and B.

Find the G.C.M. of $12m^3x - 9m^2x - 28am^2 + 21am^2$ and $9m^2x - 12m^2x - 21am^2 + 28am^2$.

$$\begin{array}{r|l} B & A \ (p \\ Bp & \\ \hline C & B \ (q \\ Cq & \end{array}$$

In this ex. $A = Bp + C$ and $B = Cq$

Because $B = Cq$, C measures B. It also measures any power of B, ∴ it measures Bp. And it measures itself ∴ it will measure $Bp + C$. But $Bp + C = A$. ∴ C measures A.

Now every common measure of A and B will measure $A - Bp$, that is, C. ∴ Every common measure of A and B is a common measure of B and C. But C is the greatest common measure of B and C, for no higher expression than C can measure C. ∴ C is the highest expression that will measure A and B, that is, their greatest common measure.

$$\begin{aligned} &12m^3x - 9m^2x - 28am^2 + 21am^2 \\ &= 3x(4m^3 - 3m^2) - 7a(4m^2 - 3m^2) \\ &= (3x - 7a)(4m^3 - 3m^2) \end{aligned}$$

$$\begin{aligned} &\text{And } 9m^2x - 12m^2x - 21am^2 + 28am^2 \\ &= 3x(3m^2 - 4m^2) - 7a(3m^2 - 4m^2) \\ &= (3x - 7a)(3m^2 - 4m^2) \end{aligned}$$

The G.C.M. of

$(3x - 7a)(4m^3 - 3m^2)$ and $(3x - 7a)(3m^2 - 4m^2)$

$= \underline{3x - 7a}$. Ans.

3. Solve the equations :—

(1) $\dfrac{x}{4} - \dfrac{x+10}{5} + 4\frac{3}{4} = x - 1 - \dfrac{x-2}{3}$

(2) $\dfrac{x-2a}{2b-x} + \dfrac{x-a}{b-x} = -2.$

(1) $\dfrac{x}{4} - \dfrac{x+10}{5} + 4\frac{3}{4} = x - 1 - \dfrac{x-2}{3}$

$$15x - 12x - 120 + 285 = 60x - 60 - 20x + 40 - 37x = -185$$

$$x = 5. \text{ Ans.}$$

(2) $\dfrac{x-2a}{2b-x} + \dfrac{x-a}{b-x} = -2$

$$(x-2a)(b-x) + (x-a)(2b-x) = -2(2b-x)(b-x)$$

$$bx - 2ab - x^2 + 2ax + 2bx - 2ab - x^2 + ax = -4b^2 + 6bx - 2x^2$$

$$3bx - 2x^2 - 4ab + 3ax = -4b^2 + 6bx - 2x^2$$

$$3ax - 3bx = 4ab - 4b^2$$

$$3x(a-b) = 4b(a-b)$$

$$3x = 4b$$

$$x = \frac{4b}{3}. \text{ Ans.}$$

Mensuration.

An oblong field is 300 yards long and 200 broad; find the distance from corner to corner. If a belt of trees, 30 yards wide, be planted round it, find the area of the interior space.

$$\sqrt{300^2 + 200^2} = \sqrt{90000 + 40000}$$

$$= \sqrt{130000} = \underline{360{\cdot}55} + \text{yds. Ans.}$$

$$(300 - 60)(200 - 60) \text{ yds.}$$

$$= 240 \times 140$$

$$= 33600 \text{ sq. yds.}$$

$$= \underline{6 \text{ acres } 4560 \text{ yds.}} \text{ Ans.}$$

Arithmetic.

FEMALES.

1. Prove that $2{\cdot}4\dot{5}$ multiplied by $3{\cdot}1\dot{6} \div {\cdot}01\dot{2}\dot{6}$ is equal to $615{\cdot}\dot{6}$.

$$2{\cdot}4\dot{5} \times 3{\cdot}1\dot{6} \div {\cdot}01\dot{2}\dot{6} = 615{\cdot}\dot{6}$$

$$= 2\tfrac{45}{99} \times 3\tfrac{16}{99} \div \tfrac{126}{9999} = 615\tfrac{66}{99}$$

$$= \tfrac{243}{99} \times \tfrac{313}{99} \times \tfrac{9999}{126} = \tfrac{6087}{9}$$

$$= \underline{\underline{676\tfrac{3}{9} = 676{\cdot}\dot{3}}}. \text{ Ans.}$$

2. Divide 21·3962 by ·527, and 213962 by ·000527.

$$\begin{array}{r|l} ·527 & 21{\cdot}3962 \ (40{\cdot}\dot{6} \\ & 21\ 08 \\ \hline & 3162 \\ & 3162 \\ \hline & \end{array} \quad \text{Ans.}$$

$$\begin{array}{r|l} ·000527 & 213962{\cdot}000000 \ (406{,}000{,}000 \\ & 2108 \\ \hline & 3162 \\ & 3162 \\ \hline & 000000 \end{array} \quad \text{Ans.}$$

3. A bankrupt can pay 6s. 8d. in the £; if his assets were £500 more he could pay 7s. 4d. Find his debts and his assets.

7s. 4d. − 6s. 8d. = 8d.

£500 represents 8d. in the £

£ £

As 8 : 240 :: 500 : x Debts

$= \underline{£15{,}000}$. Ans.

d. d. £ £

As 240 : 80 :: 15000 : x Assets

$= \underline{£5000}$. Ans.

4. Find the value of ·65 of £4 10s. 0d. + ·0125 of £5 13s. 4d.

·65 of 90s. = 58·50s. = ...	£2 18 6
·0125 of £5 13s. 4d. = $\frac{1}{80}$ of £5 13s. 4d. =	0 1 5
	£2 19 11. Ans.

Grammar.

MALES AND FEMALES.

1. Analyse fully the following passage :—

I would not have a slave to till my ground,
To carry me, to fan me while I sleep
And tremble when I wake, for all the wealth
That sinews bought and sold have ever earned.

ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Predicate.	Object.	Ext. of Pred.
(*a*) I would not have a slave to till my ground for all the wealth	P.S.		I	would have	a slave	not (neg.) to till my ground for all the wealth (reason)
(*b*) To carry me,	P.S. contracted co-ord. with (*a*)		[I]	[would have]	[a slave]	[not] to carry me (reason)
(*c*) To fan me	Do.		[I]	[would have]	[a slave]	[not] to fan me (reason)
(*d*) While I sleep,	Adv. s. to (*d*)	while	I	sleep		
(*e*) And tremble	As (*b*)	and	[I]	[would have]	[a slave]	[not] to tremble (reason)
(*f*) When I wake,	Adv. s. to (*e*)	when	I	wake		
(*g*) That sinews bought and sold have ever earned.	Adj. to *wealth* in (*a*)	*that* rel	sinews bought and sold	have earned	that	ever (time)

2. Give examples in sentences of your own :—

(1) Of a passive verb.
(2) Of the subjunctive mood.
(3) Of an adverbial phrase.
(4) Of an adverbial sentence.

(1) Julius Cæsar *was murdered* by the conspirators.
(2) If he *be* a traitor, he will certainly betray us.
(3) The children were playing *very happily on the common.*
(4) I laid it *where it could easily be seen.*

3. Write out the first eight lines of the poetry which you have learned by heart this year; and then write the substance of it in your own words.

4. Explain the significance of the final syllable in each of the following words; say to what language the words belong, and give two other examples of the same formation in each case: christian*ize*, glori*fy*, black*ish*, reduc*tion*, shepherd*ess*, gracious, merci*ful*.

-ize = to do or to make; Greek.—baptize, moralize.
-fy = to do or to make; Latin,—magnify, satisfy.
-ish = a little or somewhat; Saxon,—whitish, brownish.
-tion = action; Latin,—action, election.
-ess = female agent; Latin,—governess, sorceress.
-ious = full of; Latin,—glorious, envious.
-ful = full of; Saxon,—thankful, sinful.

Geography.

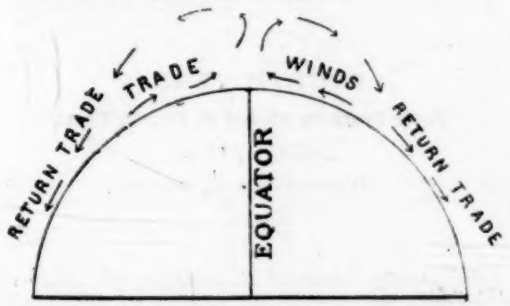
(*Answer Q.* 1, *and either Q.* 2, *or Q.* 3.)

1. Draw a map of Africa.

2. Give the causes of the trade winds, and illustrate by a diagram.

The heat at the equator is so great that the air becomes rarefied and ascends. The colder air from the north and south of the equator rushes in to fill the place of that which has become rare and ascended, blowing from north and south. The motion of the earth at the equator is however faster than the land at a distance. The north and south winds are as it were thus left behind and become N.E. and S.E. winds. As the heated air which has ascended flows off towards the poles it becomes cooler and nears the surface of the earth again in latitudes 40° to 50° N. and S. These winds are known as the return trade winds.

The following diagram illustrates the text :



3. Give a full account of the Himalayas, of the plateau of Thibet, and of the desert of Gobi.

The Himalaya range (1500 miles long) is the highest in the world. It runs from east to west, and the average height of the peaks is 20,000 feet. Mt. Everest (29,000 feet) is the highest peak. Other peaks are Kunchinjinga and Dhawalagira. The range has a width of from 200 to 400 miles. The longest slope is towards the north. Its peaks are covered with perpetual snow, and the range is the source of the Ganges, Indus, Brahmapootra, and other rivers.

Thibet is the loftiest plateau in the world, in no place being less than 12,000 feet above the level of the sea. It lies immediately to the north of the Himalayas, and is bounded on the north by the Kuen Luen Mts., on the west by the continuation of the Himalayas, and east by China. Its climate is dry in summer, and cold in winter.

The desert of Gobi lies between the Kuen Luen Mts. on the south, and the Altai Mts. on the north. It occupies nearly all Mongolia, and is 1500 miles long by 1100 miles broad. It is a rainless region, and has immense tracks of sand and salt. It is called Shamo by the Chinese.

4. Describe the region of the Nile and give a brief account of the Soudan.

The Nile, the river of Egypt, flows from the centre of Africa in a northerly direction to the Mediterranean Sea. Its chief branch, the Bahr-el-Abiad, or White Nile, rises in Lake Nyanza. At Khartoum in Nubia it is joined by the Bahr-el-Azrek, or Blue Nile, from Abyssinia. Descending several cataracts it enters Egypt by a valley somewhat contracted. At Cairo the valley widens, and the river separates into two great arms, forming a fruitful delta, at the eastern extremity of which stands Damietta, and at the western Rosetta. The length of the river is probably 3000 miles.

Soudan is the name given to the district of Central Africa south of the Sahara, and comprises the regions watered by the Niger, the district around Lake Tchad, and the Egyptian possessions of S. Nubia, Darfur, Kordofan, and the valley of the Nile to the equator. Its inhabitants are chiefly negroes, who have been conquered by Arab tribes, and these in turn by the Egyptians. A general rising of the Arabs, under the Mahdi, is now in progress. Many of the Egyptian garrisons have been massacred.

5. Describe briefly the Chinese Empire.

The Chinese Empire lies to the east of Asia. It is bounded on the N. by Siberia, on the W. by Siberia and Turkestan, on the S. by India and Burmah, and on the E. by the Pacific. It includes China Proper, Thibet, Mongolia, and Manchooria. It contains 4½ million sq. miles, and has a population of probably 435 millions. Its rivers are Hoang-ho, Yang-tse-kiang, Peiho, and Canton; its towns Pekin, Nankin, Canton, Shanghai, Foochow, and many others. It is governed by an emperor, its people are industrious and skilful. For thousands of years the arts of civilisation have been known amongst them, but they are very exclusive, and dislike foreigners.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. What is meant by banker's discount? If a merchant takes a bill of £550 to be discounted, and the banker gives him £533 10s. for it, what percentage has the banker charged?

Banker's discount is the money he deducts for paying a bill before due, and is equal to the interest which would be made by the sum named in the bill from the time when discounted to the time when due, at the given rate per cent.

Deduction = £550 − £533 10s. = £16 10s.

Deduction per cent. =

£	s.	£
As 550	: 100 ::	16 10 : x = £3 per cent. Ans.

2. What numbers multiplied by themselves will produce 398·0025 and 32·1 respectively?

398·0025(19·95. Ans.
1
29)298
261
389) 3700
3501
3985) 19925
19925
.....

32·1 = 32⅛ = ⁹⁶⁄₃
√⁹⁶⁄₃ = ⁴⁄₇ = 5⅔
= 5·6. Ans.

3. A man left £25,750 to be divided amongst his children in the proportion of ½ to his eldest son, ¼ to each of his second and third sons, and ⅛ to his daughter. Find the shares of each.

½, ¼, ¼, ⅛ = 40, 24, 24, 15.
Total parts = 103.

$\frac{10}{16\frac{1}{2}}$ of £25,750 = £10,000 to eldest son.

$\frac{6}{16\frac{1}{2}}$ „ „ = £6000 to 2nd and 3rd sons.

$\frac{3}{16\frac{1}{2}}$ „ „ = £3750 to daughter.

4. If a man walks 168 miles in 4 days, and he walks 3 miles each day (after the first) more than on the preceding day, how many miles did he walk the first day?

On the second day he walked 3 miles more than the first.
„ third „ „ 3+3=6 „ „
„ fourth „ „ 6+3=9 „ „
Total distance walked above the common distance
=3+6+9=18.

Distance on first day $= \frac{168-18}{4} = 37\frac{1}{2}$ miles. Ans.

History.

MALES AND FEMALES.

1. The eldest sons of Henry VII., James II., Queen Anne, and George II., did not come to the throne. What can you tell about those princes?

Arthur was the eldest son of Henry VII., and died in 1502 while quite young. He left a widow, Catherine of Arragon, who afterwards became the first wife of his brother, Henry VIII.

James II. was deposed while his son was an infant. During the reign of Anne there were many intrigues to secure the succession to his son, under the title of James III. They were unsuccessful. He tried, personally, to obtain the throne in 1715, but was unsuccessful. He died at St. Germains in 1765.

Queen Anne's children all died in infancy. William, the eldest, was a youth of considerable promise, but died in his twelfth year, in 1700.

The eldest son of George II. was Frederick, Prince of Wales. He frequently quarrelled with his father owing to his ungovernable temper, and died unregretted in 1751. His son became George III.

2. What do you know about the wife and mother of William III.?

The mother of William III. was the eldest daughter of Charles I., who married Prince William of Nassau. William's wife was his cousin, the eldest daughter of James II. She was crowned queen and reigned along with William III. from the Revolution in 1689 to her death in 1694, under the title of Mary II. She died of small-pox.

3. Where and when was the battle of Waterloo fought? What nations were engaged in it, and with what result?

The battle of Waterloo was fought on Sunday, June 18th, 1815, at Waterloo, a place about nine miles from Brussels, the capital of Belgium.

The combatants were the French under Napoleon Bonaparte, Emperor, and the allied armies of England, Belgium, Holland, and Hanover, under Wellington. The Prussians under Blucher arrived when the battle was nearly over, and joined in the pursuit of the French. The French were totally defeated, 30,000 being killed, Napoleon fled, abdicated, and was taken prisoner, dying in St. Helena. Peace followed, and lasted nearly forty years.

Teaching.

Show how and with what illustrations you would give a first lesson to young children on *one* of these subjects:—

Silver coins.
A pronoun.
A waterfall.

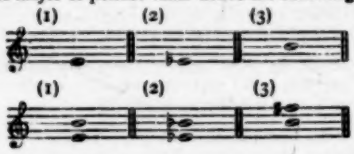
Silver Coins.—Talk about what the children like, how they get things they like, and when they cannot get them at home, how they can be had at a shop. Proceed to speak of buying with money, and ask the names of pieces they had seen, showing halfpenny and penny. These made of bronze. A brighter and more valuable metal called silver. Silver more scarce than copper, therefore a little of it will equal a much larger piece of copper. Compare a penny and a shilling, as to colour, appearance, weight, and value. The latter worth twelve of the former. Show other coins, threepenny, fourpenny, and sixpenny pieces, florin, half-crown, and crown. State their values, and give numerous exercises in expressing one in terms of the other, thus—a shilling=2 sixpences, 3 fourpences=4 threepences, and is half a florin, etc. Show that all bear the effigy of the Queen, and other marks.

Music.

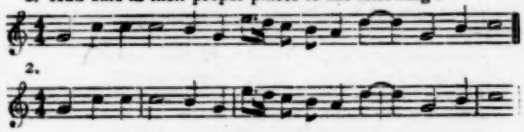
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write major or perfect fifths above the following notes:—



2. Add bars in their proper places to the following:—



3. State (briefly) the meanings of the following:—(1) *Pianissimo*; (2) *a tempo*; (3) *Adagio*.

3. (1) Very soft; (2) in time; (3) very slow.

TONIC SOL-FA NOTATION.

1. Write major or perfect fifths above the following notes:—(1) *soh*; (2) *doh*; (3) te_1.

1. (1) *soh*, ray^1; (2) *doh*, *soh*; (3) te_1, *fe*.

2. Re-write the following in four-pulse measure, doubling the value of each note:—

|n :— |s .l :f |r :d .t_1 |f :n ‖

2.

|n :—|—:—|s :l |f :— |r :—|d :t_1 |f :—|n :— ‖

3. State (briefly) the meanings of the following:—(1) *Pianissimo*; (2) *a tempo*; (3) *Adagio*.

3. (1) Very soft; (2) in time; (3) very slow.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* are admissible.]

Answer two Questions, including No. 3, if you can.

1. If two angles of a triangle be equal to each other, the sides also which subtend, or are opposite to, the equal angles, shall be equal to one another.

Euclid, Bk. I., Prop. 6.

2. If a straight line be divided into any two parts, the square on the whole line is equal to the squares on the two parts, together with twice the rectangle contained by the parts.

Euclid, Bk. II., Prop. 4.

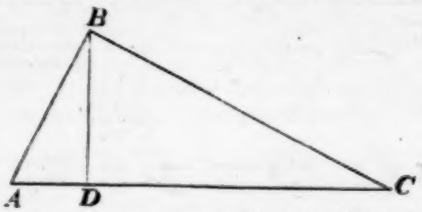
3. If the square on the perpendicular from the vertex of a triangle on the base is equal to the rectangle contained by the segments of the base, the vertical angle is a right angle.

Let ABC be a △, and AD a perpendicular let fall from the vertical ∠ to the base so that the sq. on AD = the rectangle contained by BD, DC.

Then ∠ BAC is a right ∠.

The sq. on AB=sqs. on BD, DA, and sq. on AC=sqs. on CD, DA (I. 47) ∴ sqs. on BA, AC=sqs. on BD, DC+2 sq.

on AD. And sq. on BC = sqs. on BD, DC + 2 rectangle BD,



DC (II. 4). But sq. on AD = rectangle BD, DC (Hyp.) ∴ 2 sq. on AD = 2 rect. BD, DC. ∴ sq. on BC = sqs. on BA, AC. ∴ ∠ BAC is a right ∠ (I. 48).

Q. E. D.

Algebra.

Answer two Questions, including No. 2, if you can.

1. If $\frac{a}{b}=\frac{c}{d}$ show that $\frac{a+b}{a-b}=\frac{c+d}{c-d}$, and that $\frac{a}{b}=\frac{ma+nc}{mb+nd}$

(*a*) $\frac{a+b}{a-b}=\frac{c+d}{c-d}$

Let $\frac{a}{b}=x$, then $a=bx$ and $c=dx$

Substituting the value of a

$$\frac{a+b}{a-b}=\frac{bx+b}{bx-b}=\frac{b(x+1)}{b(x-1)}=\frac{x+1}{x-1}$$

Also $$\frac{c+d}{c-d}=\frac{dx+d}{dx-d}=\frac{d(x+1)}{d(x-1)}=\frac{x+1}{x-1}$$

Since $\frac{a+b}{a-b}$ and $\frac{c+d}{c-d}$ each $=\frac{x+1}{x-1}$

$$\therefore \underline{\frac{a+b}{a-b}=\frac{c+d}{c-d}}$$

(*b*) $\frac{a}{b}=\frac{ma+nc}{mb+nd}$

As before let $\frac{a}{b}=x$ ∴ $a=bx$ and $c=dx$

And $a+c=bx+dx$ or $x(b+d)$

$$\therefore\ x=\frac{a+c}{b+d}$$

But $ma=mbx$ ∵ $a=bx$

And $nc=ndx$ ∵ $c=dx$

$$\therefore\ ma+nc=mbx+ndx=(mb+nd)x$$

$$\therefore\ x=\frac{ma+nc}{mb+nd}$$

But $x=\frac{a}{b}$ $\therefore\ \underline{\frac{a}{b}=\frac{ma+nc}{mb+nd}}$

2. Explain, as to a boy beginning quadratic equations, the general rule of solving a simple form, *e.g.*, $x^2+px+q=0$.

Solve :— (1) $x^2-x-342=0$.

(2) $\frac{x^2}{a^2}-\frac{a^2}{b^2}=\frac{a^2}{b^2}-\frac{x}{b}$.

Rule.—Place the quantities containing x, or any power of x, on the left, and the remaining quantities on the right of the sign of equality (thus, $x^2+px=q$). Add to each side half the coefficient of x squared, thus $\left(\frac{p}{2}\right)^2$. Then extract the square root of each side, and the value of x will be obtained as in simple equations.

Adding half the coeff. of x completes the square. In the general results in mult. it will be seen that the square of a binomial is the sum of the sqs. of the terms + or − twice their product. If we know the sq. of the first term, and the coefficient of x in the second term of the sq., the third term of the sq. is, as stated, half the coefficient squared. If added to one side the equation it must also be added to the other.

As *like signs* give + in the product, the sqdare root of the right-hand term will be + or − according to the terms of the question.

(1) $x^2-x-342=0$

$x^2-x=342$

$x^2-x+(\frac{1}{2})^2=342+(\frac{1}{2})^2$

$x-\frac{1}{2}=\pm\frac{37}{2}$

$\underline{x=+19 \text{ or } -18.}$ Ans.

(2) $\frac{x^2}{a^2}-\frac{a^2}{b^2}=\frac{a^2}{b^2}-\frac{x}{b}$

$b^2x^2-a^4=a^4-a^2bx$

$b^2x^2+a^2bx=2a^4$

$x^2+\frac{a^2}{b}x=\frac{2a^4}{b^2}$

$x^2+\frac{a^2}{b}x+\left(\frac{a^2}{2b}\right)^2=\frac{2a^4}{b^2}+\left(\frac{a^2}{2b}\right)^2$

$x+\frac{a^2}{2b}=\pm\frac{3a^2}{2b}$

$\underline{x=\frac{a^2}{b} \text{ or } -\frac{2a^2}{b}}$ Ans.

3. Two lame men had a race which lasted 5 minutes; one had a start of 20 yards, but the other went half as fast again and won by 30 yards. Find the length of the course.

Let x = length of course in yds.

$\frac{x}{5}$ = No. yds. run per min. by faster runner.

$\frac{(x-20)-30}{5}$ = ,, ,, ,, ,, slower ,,

The speed of the slower runner is $\frac{2}{3}$ that of the faster runner.

$$\therefore\ \tfrac{2}{3}\left(\frac{x}{5}\right)=\frac{x-50}{5}$$

$$\frac{2x}{15}=\frac{x-50}{5}$$

$$2x=3x-150$$

$\underline{x=150 \text{ yds.}}$ Ans.

Mensuration.

If a pressure of 15 lbs. on every square inch be applied to a circular plate 3 feet in diameter, find the total pressure to the nearest hundredweight.

Pressure in lbs. $=(\frac{1}{2}\text{ dia.})^2\times 3\frac{1}{7}\times 15$

$$\therefore \text{ Total pressure in cwts.}=\frac{18\times 18\times 22\times 15}{7\times 112}$$

$\underline{=136\frac{7}{14} \text{ cwt.}}$ Ans.

Arithmetic.

FEMALES.

1. Find the principal which, in $4\frac{1}{2}$ years at $4\frac{1}{2}$ per cent., will amount to £962.

£

Int. on £100 $=4\frac{1}{2}\times 4\frac{1}{2}=20\frac{1}{4}$.

In $4\frac{1}{2}$ yrs. £100 becomes £$120\frac{1}{4}$.

£ £ £ £

∴ As $120\frac{1}{4}$: 962 :: 100 : x

$\underline{=£800}$ Ans.

2. *A* and *B* together can do a piece of work in 30 days, *B* by himself can perform the same in 70 days. In what time could *A* do it alone?

A and *B* do $\frac{1}{30}$ in a day.

B does $\frac{1}{70}$,,

A does $\frac{1}{30}-\frac{1}{70}=\frac{4}{210}$,,

∴ *A* will take $\frac{210}{4}=\underline{52\frac{1}{2} \text{ days.}}$ Ans.

3. At what times between 6 and 7 are the hands of a clock at right angles?

The minute hand can be twice at right angles to the hour hand during the hour, viz., when it is 15 mins. before the hour hand, and when 45 mins. before it.

As the min. hand travels 60 mins., while the hour hand travels 5 mins. it gains 55 mins. in the hour.

∴ Time when at right angles =

m. m. m. m.

∴ 55 : 15 :: 60 : x

$\underline{=16\frac{4}{11}}$ mins. past 6.

and ∴ 55 : 45 :: 60 : x

$\underline{=49\frac{1}{11}}$,, ,,

} Ans.

4. A person in his will directed that $\frac{1}{2}$ his property should be given to A, $\frac{1}{4}$ to B, $\frac{1}{8}$ to C, and $\frac{1}{5}$ to D; show that this disposition cannot be carried out. If his property amounted to £471 12s. 6d., dispose of it so that their shares may have to one another the relation he intended.

$\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\frac{1}{5}=\frac{17}{10}$ which is more than 1, the whole property.

Divide the property into 77 parts, giving them 30, 20, 15, and 12.

	£	s.	d.	£	s.	d.
30/77 of 471	12	6	=	183	15	0
20/77 ,,	,,		=	122	10	0
15/77 ,,	,,		=	91	17	6
12/77 ,,	,,		=	73	10	0
Proof	471	12	6			

Ans.

Grammar.

MALES AND FEMALES.

Ethereal minstrel, pilgrim of the sky,
Dost thou despise the earth where cares abound?
Or while the wings aspire, are heart and eye
Both with thy nest upon the dewy ground?
Thy nest which thou canst drop into at will,
Those quivering wings composed, that music still.

Leave to the nightingale her shady wood,
A privacy of glorious light is thine,
Whence thou dost pour upon the world a flood
Of harmony, with instinct more divine;
Type of the wise, who soar but never roam,
True to the kindred points of heav'n and home.

WORDSWORTH, *Ode to a Skylark.*

(*a*) Paraphrase these verses.

(*b*) Analyse the first four lines of the second stanza.

(*c*) Select from the passage any word which you know to be of Latin origin. Give its root, and mention any other words similarly derived.

(*d*) Say whether there is any one of the rhymes less perfect than the rest, and give a reason for your answer.

(*a*) Heavenly songster! wanderer through the sky! dost thou fly to the heavens because thou art scornful of earth and its cares? Or while thou art so high on wing, are both thy sight and thought on the spot where thy nest is placed, and into which thou canst at pleasure fall, thy singing hushed and thy beating wings at rest?

The shady covert of the wood may be left to the bird of night; thy privacy is just as great although thou art surrounded by the blaze of day, and from thy lonely height thou dost more truly bless the world with thy wealth of song. In this thou art a fit emblem of the wise and good, who rise above their fellow-men, but are ever loyal to the twin-like places, heaven and home.

(*b*) ANALYSIS.

Sentence.	Kind of Sentence.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) Leave to the nightingale her shady grove	Princ. sent.		[thou]	leave	her shady grove to the nightingale	
(*b*) A privacy of glorious light is thine	Princ. sent.		thine	is a privacy of glorious light		
(*c*) Whence thou dost pour upon the world a flood of harmony with instinct more divine.	Adj. sent. to (*b*)	whence	thou with instinct more divine	dost pour	a flood of harmony	upon the world (place)

(*c*) *Aspire:* from *a* or *ad*, to, and *spira*, to breathe.
Other words from same root: inspire, conspire, respire.

(*d*) The least perfect rhyme is that of *sky* and *eye*.
The identity of the vowel sounds is the same, but the consonant sound of the latter part of the rhyme, although different, does not form part of the one syllable with the vowel sound as in the first part of the rhyme.

2. Say when Shakespeare, Milton, and Wordsworth lived, and what they wrote.

Shakespeare (1564-1616) wrote plays, sonnets, and minor poems. His plays were tragedies, comedies, and historical plays; *e.g.*, 'Hamlet,' 'Midsummer Night's Dream,' 'Julius Cæsar.'

Milton (1608-1674) wrote poems ('Paradise Lost and Regained,' 'Comus,' 'Samson Agonistes'), and many political pamphlets, chiefly in defence of the Commonwealth.

Wordsworth (1770-1850) wrote poems, descriptive sketches, lyrical ballads, sonnets, 'The Excursion' and 'The Prelude.'

Geography.

(*Answer two Questions.*)

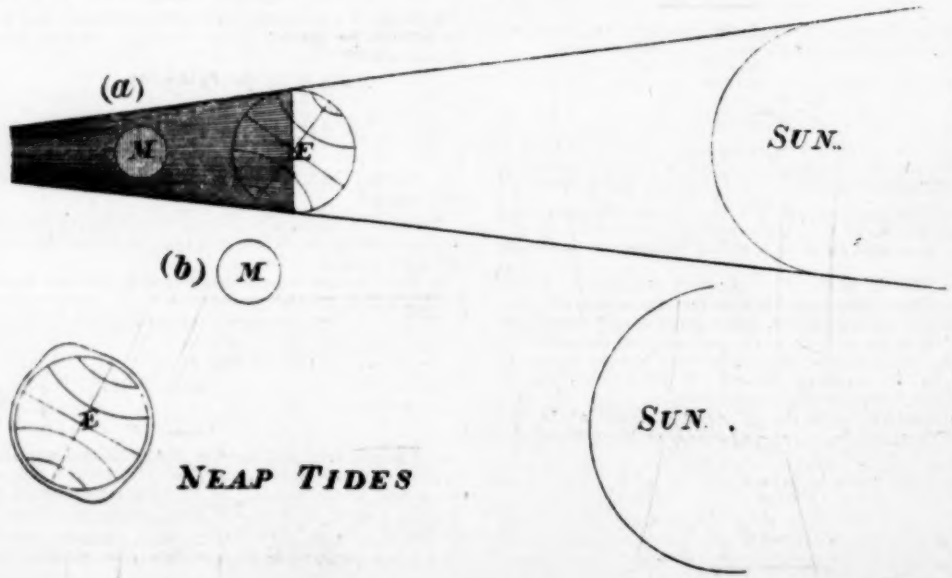
1. Draw a map of South America.

2. Enumerate the five planets nearest to the earth, and account for the occasional apparently retrograde motion of the superior planets.

Mercury, Venus, Mars, Jupiter, Saturn.

The apparently retrograde motion of the superior planets is due to their own motion and that of the earth round the sun. Venus and Mercury revolve round the sun in 225 and 88 days respectively. The whole of their orbits is within the earth's orbit. Part of their motion for a certain distance will therefore be from W. to E. When at certain angles on opposite sides they will appear stationary, and then the motion will be from E. to W. when they are between the earth and the sun. This apparent motion from E. to W. is their retrograde motion.

3. Make diagrams illustrating an eclipse of the moon, and neap tides: and show why an eclipse of the moon does not take place every month.



NEAP TIDES

An eclipse of the moon does not take place every month because the plane of the earth's orbit and the plane of the moon's orbit are not identical. The light of the sun can thus reach the moon even when the earth appears to be between the moon and the sun; the sun shining as it were on the moon over or under the earth.

4. Describe a journey to India, viâ Vienna and the Suez Canal.

London being left behind we proceed to the Continent from Harwich, on the Essex coast. Crossing the North Sea we arrive at Flushing, and proceed by Coblentz, Carlsruhe, Munich, to Vienna on the Danube. This is the capital of Austria, and is a large city of 1,000,000 inhabitants, and the chief manufacturing town of the empire. From Vienna we may take the route southwards to Trieste, the chief port of Austria, on the Adriatic, or pass through Italy, calling at Florence, Rome, and Naples, to Brindisi. Sailing from Trieste down the Adriatic through the Straits of Otranto, we proceed S.E. to the entrance to the Suez Canal at Port Said. The Canal is 75 miles long and passes through the Bitter Lakes, joining the Red Sea by its westernmost arm at Suez, Ismailia being passed on the way. On the Red Sea, we are troubled with the intense heat. Suakim lies on the W., midway down the sea. At Aden, near the entrance, we get coal, and sail in a N.E. direction across the Arabian Sea, to Bombay, the largest port on the W. coast of India.

5. Enumerate the chief productions of Jamaica, Newfoundland, Japan, and Ceylon.

Jamaica.—Sugar, rum, coffee, allspice, pimento, logwood, arrowroot, and ginger, fruits in abundance, including cocoa-nuts, breadfruit, oranges, mangoes, and pears.

Newfoundland.—Fish (especially cod), seal-oil, cod-oil, train-oil, dried fish, tinned fish (salmon, lobster, and crab).

Japan.—For export little; rice, tea, cotton, camphor trees are cultivated, silk, cotton, porcelain, lacquered work exported.

Ceylon.—Coffee, cocoa-nuts, cocoa-nut oil, linseed-oil, spices, pearls, fancy woods, rice, cinnamon, hemp, linseed.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. If a grocer gains 5 per cent. by selling tea at 2s. 6d. a lb., what per cent. would he gain by selling it at 2s. 8d. a lb.?

By selling at 2s. 6d. £100 becomes £105

s. d.	s. d.	£	£
2 6	: 2 8 ::	105	: x

$= 112$

£112 − £100 = 12 per cent. gain. Ans.

2. Find the exact value, or the approximate value to 3 decimal places of $\frac{\sqrt{\cdot 9}+\sqrt{\cdot 4}}{\sqrt{\cdot 9}-\sqrt{\cdot 4}}$

$$\frac{\sqrt{\cdot 9}+\sqrt{\cdot 4}}{\sqrt{\cdot 9}-\sqrt{\cdot 4}} = \frac{\cdot 9486+\cdot 6324}{\cdot 9486-\cdot 6324}$$

$$= \frac{1\cdot 5810}{\cdot 3162} = 5. \text{ Ans.}$$

3. An army of 20,000 men had rations for 30 days, but after 6 days 5000 men were sent away, and after 8 days more 3000 were sent away. How long beyond the 30 days did the rations last?

The amount of food left when 5000 are sent away will support 20,000 for 24 days. It will therefore support 15,000 for

		days	days
15,000	: 20,000 ::	24	: x

$= 32$ days.

These live upon it for 8 days and the remainder would therefore serve them 24 days, or would serve (15,000 − 3000) = 12,000 men for

		days	days
12,000	: 15,000 ::	24	: x

$= 30$ days.

Total time beyond 30 days = (6 + 8 + 30) − 30 = 14 days. Ans.

4. A invests a sum of money in 3 per cents. at par, and B an equal sum in 5 per cent. railway stock. If A's and B's dividends are as 7 to 8, find the price of the railway stock, brokerage being omitted.

If 3 per cent. produces 7 for A, then 8 is produced for B by

As 7 : 8 :: 3 : x

$= 3\frac{3}{7}$ per cent.

If B gets $3\frac{3}{7}$ per cent. for his money, the price of the railway stock is

		£	£
As $3\frac{3}{7}$	: 5 ::	100	: x

$= 145\frac{5}{8}$. Ans,

History.

MALES AND FEMALES.

1. Among the early English people what rights depended upon the holding of land?

In the time of the Saxons the possession of at least five hides of land entitled the holder to the rank of thane.

The possession of great quantities of land gave the holders the right of having their word counted as against that of six or twelve ceorls in courts of justice.

The thanes and ealdormen formed the principal part of the Witan.

To them belonged the right of appointing a new king. They were also the advisers of the king, and the judges in courts of justice.

2. How did James II. lose the throne? Why in the settlement of the Crown were descendants of Charles I. passed over?

James II. wished to re-establish the Roman Catholic religion in the country, and to open the public offices and Parliament to his co-religionists. He thus alienated the loyalty of his people by selecting Roman Catholic privy councillors, appointing a R. C. governor of Ireland, reviving the Court of High Commission, appointing R. C. president of Magdalen College and Dean of Christchurch, by issuing a *Declaration of Indulgence*, and ordering it to be read in the churches, by trying the seven bishops for refusing to obey the order and petitioning against it, and by generally acting in opposition to the laws of the country.

Because it was deemed inconsistent with the safety and welfare of the kingdom to be governed by Popish princes.

3. What were the 'six points' demanded by the Chartists? Describe the attempt to enforce their demand, and say how far it has now been conceded.

The six points of the People's Charter were:—Universal suffrage (excluding women), equal electoral districts, vote by ballot, annual parliaments, no property qualification for members, and payment of members.

The Chartists mustered in large numbers on Kennington Common, April 10th, 1848, marched through London to the House of Commons to present a monster petition embodying their claims. The affair passed off quietly without the need of troops, which were in readiness, under the Duke of Wellington. Several of the ringleaders were imprisoned, but the Chartists from that time ceased to be of importance as an organised body.

Since 1848 the property qualification has been abolished, vote by ballot adopted, and household suffrage is in existence in boroughs, and will probably be extended to the counties in a short time.

4. Describe the principal extensions of territory made by the English since the beginning of this century.

The following is a list of the extensions of the British empire during the nineteenth century:—

India—a very large portion annexed, including Assam, Aracan, Tenasserim, Sinde, Punjab, Nagpore, Oude.

Western Australia, South Australia, Tasmania, New Zealand, Victoria, colonised and made into separate districts.

Natal, British Kaffraria, settled, and Guiana and Cape Colony taken from the Dutch.

British Columbia made a colony, and nearly the whole of the colonies in N. America united in one dominion of Canada.

Fiji and Ascension annexed; Cyprus in the Mediterranean, and islands in the W. Indies and other places taken or ceded. Extensions of territory in Asia, Africa, and Oceania are still taking place.

Teaching.

Sketch out the notes of a lesson on one of these subjects :—

Glaciers.
Decimal fractions.
A tan-yard.

Formation of glaciers.—Speak of snow line, and district near it. Partial melting of snow and freezing again during winter. Repeated falls of snow, and constant accumulation. Plateaus at or near or above the snow-line most favourable places for their formation.

Movements of glaciers.—Great weight of accumulated snow pushes glacier forward towards the lowest level, valleys thus gradually filled with them. Movements rapid or slow often according to the heat of summer and cold of winter. Rate from a few inches to several hundreds of feet in a year.

Action of glaciers.—Grinding action on the sides of the valleys, rocks smoothed, *debris* carried down and deposited along the sides of valleys, (*moraines*), great stones often carried considerable distances.

Danger of crossing glaciers.—Ice often cracks, great crevices formed, (*crevasses*), these sometimes covered with snow, prove traps for unwary travellers.

Famous glaciers.—In Norway, Jostedal and Folge Fonde. In Switzerland, Rhine and Rhone glacier, etc.

Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

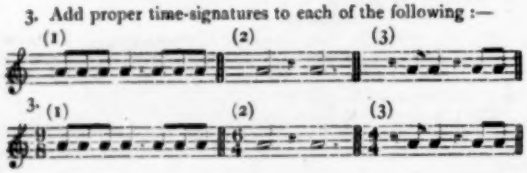
1. Write in the treble clef the signature and the ascending scale of F♯ minor, using the major or sharp sixth and the sharp seventh.

1.

2. Write an augmented fifth above each of the following notes :—

2.

3. Add proper time-signatures to each of the following :—



TONIC SOL-FA NOTATION.

1. Write an augmented fifth above each of the following notes :—(1) *fah*; (2) *soh*; (3) *ray*.

1. (1) *fah*, *de*^{1}; (2) *soh*, *re*^{1}; (3) *ray*, *le*.

2. Write the minor scale (*lah* mode), using the minor or flat sixth and the major or sharp seventh.

2. l, t, d r m f se l

3. Write the following in six-pulse measure by trebling the value of every note :—

|s ,l ,s :f |f :-.s :m ‖

3. |s :l :s |f :- :- |f :- :s |m :- :- ‖

Matriculation Hints.

BY HENRY A. REATCHLOUS, M.A. (LOND.), B.Sc.,

Westminster Training College.

THE following are translations of the passages set at the recent matriculation examination of the London University (see page 237) :—

LATIN.

1. 'Cnaeus Lentulus the consul complaining in a public speech of the great power of Pompeius the Great, when the populace loudly applauded; "Shout, citizens," cried he, "shout while you may; soon you will not be permitted to do so unpunished."'

The *ad* in *adclamate* gives the notion of an applauding shout.

2. It is my delight to go to the forest, and when the deer are driven into the nets to cheer on the fleet hounds over the high ridges, or poise (lit., brandish) the quivering javelin with outstretched arm, or lay my limbs on the grassy earth: often it is joy to steer the light car over the dusty course, or guide my flying horse's head with the rein.

3. Diogenes at Syracuse, on Aristippus saying to him as he was washing some pot-herbs: 'If you wanted to flatter Dionysius you would not eat those things,' replied, 'Nay, if you wanted to eat these things, you would not flatter Dionysius.'

Esses is imperf. subj. of edo.

Ista sc. olera: the pronoun is contemptuous.

GREEK.

1. For a woman it is more seemly to stay at home than to gad about the streets, but for a man it is a reproach to stay at home rather than to take an interest in public business.

2. When Tithraustes offered rich gifts if he would quit the country, Agesilaus replied, 'With us, Tithraustes, it is held more honourable for a general to enrich his army than himself, and to endeavour to win spoils rather than receive gifts from the enemy.'

3. Of many issues is Zeus in Olympus the dispenser, and many do the gods accomplish against our hopes; and so the expected event fails of fulfilment, whilst for the unexpected god finds a way.

(1) ταμίας, lit., a house-steward who distributes food to the household; Lat., *dispensator*; cf. '*dispensing* to every man severally,' etc.

For line 2: 'God fulfils Himself in many ways.'—*Tennyson.*

(2) ἐτελέσθη—εὗρεν. These aorists are called *gnomic* aorists, as being the tense commonly used in proverbs (γνῶμαι) of what has occurred in the past, and, by implication, is liable to repeat itself. We use the present in English in such cases.

Force has already been defined to be the rate of change of momentum. Momentum is the product of the mass into the velocity = Mv, and as acceleration is rate of change of velocity, we can write $F = Mf$ where F stands for force, and f for acceleration. If we take a pound as the unit of mass and one foot per second per second as the unit of acceleration, the force will be expressed in poundals or British units of force. If we substitute a gram and a centimetre for a pound and a foot, the force will be expressed in dynes. In either case these units are called absolute units, inasmuch as they are independent of the force of gravity; in each case a unit of momentum is produced in a unit of time. In the C.G.S. system, therefore, the unit of force is a dyne, and a mass of one gram in the latitude of London, and at the sea-level exerts a force of 981 dynes. In the foot-pound-second system the unit of force is a poundal, and a mass of one pound in the latitude of London and at sea-level exerts a force of 32·2 poundals.

Work.—Work is the act of producing motion in a body in opposition to a force that resists it. The work done in raising the mass of one pound through vertical foot is called a foot-pound. Thirty-three thousand foot-pounds per minute is called a horse-power, being the rate at which a horse can do work.

Energy is the capacity to do work. Work may be done by a moving mass in virtue of its motion or by a mass in virtue of its position or configuration. In the first case the energy is kinetic, in the second it is potential. It is in this potential form that energy can be stored up for future use. For measuring work we need an appropriate unit. For many years the foot-pound was used in this country. This is a gravitation unit, and varies with the force of gravity at the spot. We can, however, multiply the foot-pounds by the number representing the force of gravity at the place, and thus express the work in absolute units. In the C.G.S. system the unit of work is that done by the force of one dyne moving its point of application through one centimetre, or the work done in raising the $\frac{1}{981}$ part of a gram through one centimetre against the force of gravity in the latitude of London. This unit of work is called an *erg*.

Suppose a body to be projected vertically upwards with a velocity v; its velocity at any subsequent time is given by the equation $V^2 = v^2 - 2gs$. This velocity becomes less and less till the body ceases to rise. The equation then becomes $v^2 = 2gs$; that is, the vertical height through which the body would rise would be equal to $\frac{v^2}{2g}$. Now if M be the mass of the body in grams, the work done against gravity will be $\frac{Mv^2}{2g} \times g$ ergs $= \frac{Mv^2}{2}$ ergs. To find the energy of a moving body in ergs, multiply the number expressing its weight in grams by the square of the number expressing its velocity in centimetres per second, and divide the product by two. If a mass of one pound is moving with a velocity of 32·2 feet per second, it can do $\frac{Mv^2}{2g} = \frac{1 \times 32{\cdot}2 \times 32{\cdot}2}{2 \times 32{\cdot}2}$ = 16·1 foot-pounds, or $16{\cdot}1 \times 32{\cdot}2$ foot-poundals; if the mass of 10 grams is moving with the velocity of 100 centimetres per second, it can do $\frac{Mv^2}{2} = \frac{10 \times 100^2}{2}$ = 50,000 ergs. We see that both the unit of force and the unit of length enter into the unit of work: hence in reference to the fundamental units, Work $= Fs = \frac{ML}{T^2} \times L = \frac{ML^2}{T^2}$.

Suppose a mass of 10 lbs. be moving at the rate of 50 feet per second; it can do $\frac{5 \times 2500}{32} = \frac{12500}{32}$ foot-pounds of work in coming to rest. But if in doing so it has moved the point of its application through 2 feet, then since work is $= Fs$, its average force is equal to that of $\frac{12500}{2 \times 32} = 195$ lb.

We have said that force is measured by the rate at which momentum is generated. If much momentum is generated in a short time the force must be very great. Similarly, if a great momentum, *i.e.*, that of a heavy hammer moving with great velocity, be suddenly destroyed, the force it exerts is very great. The word impulse or impact is used to denote the action of a great force acting for a very short time. We have already seen (page 173) that $F = \frac{Mv}{T}$, *i.e.*, $FT = Mv$. Hence to generate or destroy a definite amount of momentum, the force we must employ will vary inversely as the time during which it acts. With a small hammer we are thus able to produce great effects. Suppose the hammer weighs a pound, and is made to move with a velocity of 20 ft. per second; its momentum will then be $\frac{1 \times 20}{32{\cdot}2}$: suppose this momentum is destroyed in the one five-hundredth part of a second, then from the equation $FT = Mv$ we find that F is = 3105 lb. A definite force acting for a certain time always generates the same amount of momentum; if the body acted upon be great, its velocity will be small, and *vice-versa*. The equation FT = momentum must not be confused with Fs = energy.

If a body of mass m, moving with a velocity v, strike a body of mass m_1, moving with a velocity of v_1, then, if they are inelastic, they will move on with a velocity V, and the algebraical sum of their momenta will remain unchanged.

Hence $mv + m_1v_1 = V(m + m_1)$.

$\therefore V = \frac{mv + m_1v_1}{m + m_1}$. This formula is easily adapted to the case where one of the bodies is at rest.

The student should make himself familiar with the metric system, and be not only able to repeat the tables but also to attach definite ideas to such words as gram, centimetre, etc. A rule about six inches long, marked in centimetres and millimetres can be bought for a halfpenny. With the aid of this the plane side of an ordinary ruler can be marked for the sake of practice. Then pieces of paper can be cut out to illustrate square measure. To get a clear idea of a cubic centimetre, one should be cut out in wood or paraffin. A block of wood one decimetre in the side is also useful to remind one of the volume of a litre which contains 1000 cubic centimetres. A cubic centimetre of water at 4° Centigrade weighs a gram, and a litre a kilogram. By measuring the lengths and capacities of familiar objects and expressing them in the decimal system, the student will gain a better acquaintance with it than by merely learning tables and working sums.

(To be continued.)

—o—

Recent Inspection Questions.

[The Editor respectfully solicits contributions—all of which will be regarded as STRICTLY PRIVATE*—to this column. For obvious reasons, it cannot be stated in which district the questions have been set.]*

Arithmetic.

STANDARD I.

(1) 579 + 16 + 800 + 7. Ans. 1402.
(2) 950 − 74. Ans. 876.
(3) 6 × 9 = Ans. 54.

STANDARD II.

(1) 19,048 × 58. Ans. 1,104,784.
(2) 11,504 ÷ 9. Ans. 1278 − 2.
(3) 19,047 − 10,854. Ans. 8193.
(4) 110 pence = Ans. 9s. 2d. Ans. 12 × 5 = 60.

STANDARD III.

(1) Divide 375,139 by 79. Ans. 4,748 – 47.

(2) Add £4,090 17s. 8¾d., £826 9s. 10½d., £70,005 14s. 6d., £53,687 8s. 5¼d., £60 0s. 9¾d. Ans. £128,670 11s. 4¼d.

(3) From £26,392 17s. 10d. take £9,541 19s. 3¾d. Ans. £16,850 18s. 6¼d.

(4) Eggs were bought at 10d. per doz., and sold at 1¼d. each, what was the gain? Ans. 5d. a dozen.

STANDARD IV.

A.

(1) Bring 453 hhds. 45 gals. 1 pint to gills (wine), and divide the answer by 347. Ans. 2,636.

(2) Reduce 5 years, 45 weeks, 5 days, 17 hours, 49 minutes to minutes, and write out the answer in words. Ans. 3,082,669.

(3) Bring one million cubic inches to yds., ft. Ans. 21 cub. yds., 11 cub. ft., 1,216 cub. inch.

(4) If I earn daily (not counting Sundays) a pound, a shilling, a penny, and a farthing, how much do I receive in a year? Ans. £330 5s. 7¼d. in 313 days.

N.B.—This question is inexplicit, as there might be 312, 313, or 314 days, exclusive of Sundays.

B.

(1) Bring four hundred thousand square feet to acres.

Ans. 9 ac. 29 p. 6¾ sq. yd. 4 ft; or, 9 ac. 884 sq. yd. 4 ft.

(2) What is the difference in ounces between 4 cwt. 2 qrs. 17 lbs., and 1 cwt. 3 qrs. 27 lbs? Ans. 4,768 ozs.

(3) Bring 73 days 3 hrs. 24 min. to minutes, and write the answer in words. Ans. 105,324.

(4) A man bought 15 cwt. of rice for £24 10s.; how must he sell it per lb. to gain exactly £7. Ans. 4½d.

STANDARD V.

(1) The carriage of potatoes for 60 miles 6 fur. was £12 12s. 10½d.; what distance could they have been sent for £37 18s. 7½d.? Ans. 182¼ miles.

(2) Bill:—

17½	gross of pens at 3d. per doz.
15	reams of paper at 1s. 9½d. per quire.
18	score of pencils at 4½d. per doz.
1000	slate pencils at 19½d. per 50.
119	quires of paper at 1d. per sheet.

Ans. £43 11s. 9d.

(3) Find by practice the cost of painting a door 3 yds. 7 inches long, and 2 yds. 2 feet wide, at £10 per sq. yd. Ans. £85 3s. 8½d.

N.B.—A question in mensuration, at a ridiculous price per sq. yd.

(4) $(7\frac{1}{2}+9\frac{1}{4})-(6\frac{1}{2}+\frac{1}{8}+1\frac{3}{5})$. Ans. $8\frac{17}{40}$.

STANDARD VI.

(1) Simplify $\frac{7\frac{1}{3}-6\frac{1}{8}}{8\frac{1}{6}+11\frac{1}{3}} \div \frac{\cdot073+\cdot07}{\cdot73-\cdot073}$ Ans. ·2874+

(2) Reduce $\frac{2}{5}$ of £1 to the decimal of 1 guinea. Ans. ·380952.

(3) Find the value of 13·3375 acres. Ans. 13 ac. 1 rd. 14 per.

(4) If 20 men in 3 weeks earn £90, in what time will twelve men earn £150? Ans. 8½ weeks.

(5) Find simple interest on £719 17s. 9d. for 5½ years at 2½ p. c. Ans. £98 19s. 8$\frac{23}{50}$d.

Grammar.

STANDARD IV.

Parse:—

(*a*) He quickly came to blows with the enemy.

(*b*) The sight of distress always fills a benevolent mind with compassion.

STANDARD V.

Parsing and analysis:—

(*a*) Tell me nothing but the truth.

(*b*) Why have you kept this intelligence so long from us?

Dictation.

STANDARD I.

Shoe, chain, collar, shirt, neck.

STANDARD II.

Suddenly an awful storm came on. The wind blew fiercely, and great clouds of sand were lifted into the air—clouds which darkened the sun! The merchants at once jumped off their camels, covered themselves with their cloaks, and lay down; while the poor beasts closed their nostrils.

STANDARD III.

So he roams about, turning the furniture upside down; he lies on his face to peep under sofas and beds, and dirties his shirt. Failing to find the shoe, he accuses his brother of having concealed it; for a careless fellow admits his want of order only at the last extremity. It was so much the more unlucky because his mother, after reproaching him for wasting his shoes, had ordered two pairs for him; and the tradesman, as is too common, had not brought them on the day he promised, so that, for the time, he was reduced to a single pair.

STANDARD IV.

The animal was evidently in great pain, and, on passing his hand over her body, he discovered that one of her legs was fractured. He accordingly bound it up with his garter, and offered her some of his bread; but she refused to eat, and stretched out her tongue, as if her mouth was parched with thirst. He gave her water, which she drank greedily, and then she ate the bread. At midnight he ventured out, pulled a quantity of grass and tender branches of trees, and carried them to the poor sufferer, who received them with demonstrations of gratitude.

—o—

WE have received a copy of 'Hygiene' by our esteemed and able contributor, Dr. Newsholme. For obvious reasons this work cannot be noticed in the columns usually assigned to Reviews. We will therefore simply state that the doctor is eminently qualified, both as a scholar and practical teacher, to deal with this new subject of the Science and Art Department, and that he has given us an excellent, comprehensive, and reliable text-book.

Messrs. Gill and Sons, the publishers, have issued the volume in a highly creditable style.

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Portfolios, fitted with elastic bands, for preserving twelve numbers of 'The Practical Teacher,' may now be had. Price 2s. 6d. Orders should be given through booksellers.

The numbers of the *Practical Teacher* for February and March, 1884, are now out of print.

Publications Reviewed.

How Sorrow was Changed into Sympathy. By Mrs. Prentiss. London: Hodder and Stoughton.

This is a posthumous work by the well-known author of 'Stepping Heavenward.' It describes with the fullest imaginable detail the sufferings and death of two of Mrs. Prentiss's children—a little boy of four, who died of a brain affection, and a baby of a few weeks old, who succumbed to congenital feebleness. There is really nothing remarkable in the story. The little boy is not represented as phenomenally bright or exceptionally interesting. He used to eat strawberries with a pin, but this he seems to have been taught, not to have originated. His little sayings displayed no more cleverness than is common with fairly bright children. The details of the poor little fellow's illness, however, are made painfully interesting by the minuteness with which they are given. The symptoms, the sufferings, the very cries of pain are chronicled as carefully as a mother's heart might be expected to retain them for long after; but there is something cruel in the gratuitous harrowing up of the reader's sympathies by such details. One of the most painful experiences that can come to man or woman is to have to watch the anguish of a little child. Why should we thus suffer without need and vicariously through such a book as the one before us? Here are some specimens of its distressing descriptions: 'About dusk he manifested great distress, and tore hair from his head in handfuls, which I took from his clenched fingers and laid aside. . . . . He was tortured with constant nausea. . . . . His cries were fearful, and rent my heart. . . . . He appeared to sleep until the blister began to draw, when he cried out at intervals till five a.m., "O mamma! my neck!" in accents of distress which my ears will ever hear.' We do not know what advantage it can be to any one to read this kind of pitiful story, though the passion and reality with which it is told certainly give the book a curious interest when once begun.

The latter fourth of this little volume's pages are filled with letters written by Mrs. Prentiss to other bereaved mothers, ardently exhorting them to pious resignation and submission to the will of God. They are well and fervently expressed, and place powerfully before the reader all the ideas and hopes by which a Christian mother may partially solace her soul for the loss of her children. The book is handsomely bound.

Domestic Economy. By E. Rice. London: Blackie and Son.

This is one of the best *practical* books on Domestic Economy that we have seen. The writer, the late Mistress of Method at Cheltenham Training College, is evidently also an experienced housewife. Nothing could be clearer or more sensible than all her remarks and descriptions about the practical work of a household, from washing blankets or cleaning grates to managing children or cooking for the sick room. We wish we could speak with equal warmth of the scientific portion of the book. Let us hasten to say that on the whole this is accurate. It fails sometimes in fulness. For example, the necessity for gradually increasing the strength of an infant's milk diet, when it is 'brought-up by hand' is not mentioned. The instruction is twice repeated to mix for a baby one part of water with two of milk. This would be too strong for an infant of a few weeks old, and far too weak for one of seven months. Analysis shows that nature accommodates the strength of the child's natural food to its growing demands; and the same indication should be followed in artificial feeding. Sometimes Miss Rice falls into the contrary error to this in teaching theories which science would not justify. The writer is evidently a homœopathic, for she advises the domestic use of aconite, pulsatilla, calendula, and other drugs which are strange in the ears of orthodox medical practitioners, and which, to say the least, untrained women had better not pour into themselves or their children. She even goes so far as to advise the amateur to take daily doses of belladonna as a prophylactic against scarlet fever; a very questionable piece of practice for any one, and a most improper thing to be done at random by a working man's wife, whenever she gets a scare about the prevalence of fever. These errors in practical recommendation about scientific points are in marked contrast to the excellence of the practical suggestions about what Miss Rice does understand—domestic management pure and simple. She has simply

read up her science. It has not grown to be a part of the furniture of her mind. The clearness and easiness which are so charming in her style when treating of the details of cooking and cleaning are lost in the chapters on the 'Composition of Animal Tissue,' 'Mineral Food,' 'Digestion,' and the like topics. School-girls will not understand, if left to themselves, one word of her description of gases and elements and the like. Nor would it be any use to them to learn by rote such statements as, 'The food is first taken to the mouth, and this act is called PREHENSION'; or 'scalded milk is very good in *affections of the alimentary canal*,' or 'the word "gas" was never *known* till about the year 1644,' and a multitude of other more verbose and similarly useless assertions in long phraseology, which we have not space to quote. The teacher must fill out for herself the very dry bones which are all that are here presented of the scientific side of the subject, if she use Miss Rice's book. But of the practical part, we can fairly say that it would be well if every girl got it thoroughly by heart in her school-days.

The Science of Home Life. Third Year's Course. By W. Jerome Harrison, Science Demonstrator to the Birmingham School Board. London: T. Nelson and Sons.

Mr. Harrison's work is precisely the reverse of the one above reviewed. Here the science is capital, but the practical part is comparatively stunted and meagre. The topics treated are those of the third stage of domestic economy according to Schedule IV.—namely, the preparation of food, the care of health, and the management of the sick-room. The earlier chapters give an outline of human physiology, and explain the science of alimentation. This is all done admirably. We have never seen such a concise and clear exposition of these matters in so small a space. In every part of the work, reasons are given for the rules laid down. The pupil is not required here, as is so often the case in manuals on this subject, to believe certain things to be true simply because the author of the text-book has written them down, and the printer has put them in type. We have repeatedly expressed our conviction that domestic economy taught in this *ex cathedrâ* style is nearly useless, and the same judgment may be found set forth over and over again in the reports of H.M. Inspectors printed in recent blue-books. Mr. Harrison's work is a model of method in this respect. For every rule he gives a reason, and his pupils will thus not only comprehend him more completely, but will also realise the value of his teachings, and be likely to practically apply them in after life. Recipes and cookery instructions are, however, a weak point with Mr. Harrison. An intelligent woman could certainly infer the whole art of cookery out of the very full account which he gives of the principles that govern the various culinary operations, of the utensils employed in the kitchen, and of the meats and vegetables available for food. But he does not himself trace the connection between each scientific principle and the practical cookery dependent on that principle. It is true that a well-trained mind will draw this kind of deduction readily enough; but for the class for whom Mr. Harrison writes—school-girls of twelve and thirteen—the task should be undertaken by the teacher. A perfect work on the subject requires both theory and practical knowledge.

'Both butter and cheese are best eaten as they are, without any attempt at cooking them.' Does any sane creature try to cook butter as a separate *plat*? Or is this sentence aimed at melted butter? Did Mr. Harrison ever try a rice pudding made precisely according to his directions? Or does any practical cook think the following sufficient instructions in the art of making short paste: 'To make suet paste chop one quarter of a pound of suet, and mix it well with half a pound of flour; make it into a stiff paste with water, and roll out with a rolling pin. Short paste is made in the same way, but with dripping or lard instead of suet, and with the addition of a small teaspoonful of baking powder.' We draw attention to this point, not because it is of great consequence, for cookery classes are now common, and this deficiency will be made good there for the girls, but mainly because a little more care in this respect would make Mr. Harrison's quite a perfect manual of the subject.

The volume is illustrated. A special feature is the introduction of diagrams of the jointed forms of the various animals used as food, with a key giving the butcher's names for the various parts. This will be incalculably useful to young beginners in purchasing the household provisions. We recommend teachers of domestic economy to obtain this work, for it has real scientific value.

New Royal Readers. Nos. III. and IV. London: T. Nelson and Sons.

We can speak of these Readers in terms of approbation as warm as we gave to the preceding books of the same series. The matter is well selected, the illustrations are fresh, the type is clear, and the paper good.

In the Standard III. Reader, the first of the two volumes now before us, the selections are miscellaneous, and have the advantage of being new for the most part. Questions, spellings and meanings, grammatical exercises, and a précis of the matter, are appended to each lesson. Verse is scattered throughout, but a special selection of poetry for recitation, with the accents carefully marked, is placed at the end of the volume, where, also, there are a few school songs, with music in both notations.

In the Standard IV. book a novelty is introduced in a series of consecutive readings from 'Uncle Tom's Cabin.' The story is completely told, although, of course, much shortened, the actual quotations from Mrs. Stowe's famous work being linked together and made into a continuous narrative by well-written paragraphs from the pen of the editor. Every possible assistance is given both to teachers and children in this series. The Royal Readers have always been popular, and this new series, adapted to the latest requirements of the Department, will doubtless be warmly greeted by teachers.

Blackie's Geographical Readers. Nos. III. to VII. By W. G. Baker. London: Blackie and Son.

This is an excellent series of Geographical Readers. All are well illustrated, both with a profusion of maps, plain and coloured, and with pictures of some of the various scenes described. A useful summary concludes each volume; these contain, of course, greatly condensed information, and thus, for all their utility, may be called dull, but they are the only dull pages in the books. A large portion of these volumes consists of quotations from famous books of travel, sometimes taken verbatim, sometimes (in the earlier books) verbally adapted to the standard which is to read them. Even newspapers and magazines are laid under contribution. 'Scenes in Kent,' for instance, comes from the *Argosy*, and a description of the Yarmouth fisheries from the *Illustrated London News*. A speech of the Duke of Edinburgh is drawn upon for one page, and Nathaniel Hawthorne's 'Old Home' for another. This we mention to indicate how varied the contents of these Readers are.

Book III. deals with England and Wales. After a general outline introduction, treating of the size, shape, and situation of these islands, some chapters are devoted to explaining the meaning of the terms 'coast' and 'seashore.' The young reader is then taken round the coasts; next to the principal hills; and then along the chief rivers. Succeeding chapters describe the principal large towns, and the manufactures of which they are the seat; and the book concludes with a study of the counties in groups. We repeat that there is nowhere a dull page. It is not mere dry cataloguing, but bright, vivid description; and the pictures of the principal buildings, chief streets, interiors of workshops, etc., add greatly to the interest.

Book IV. treats of Scotland, Ireland, and the principal

British Colonies. The frontispiece is a map of the world, showing the British possessions coloured red. This volume has the addition of a few pieces of verse of much interest. One called 'Settlers' Difficulties' is stated to be the first recorded poem written in America, and is dated 1630. Another old poem is described as having been written by a waterman of London in the time of James I., and is descriptive of the Anglo-Scottish border. Accounts of the adventures of emigrants and explorers will be an attractive feature of this volume to the young reader.

Number V. is the volume devoted to Europe, and has an excellent coloured map. The names of the Continental towns are spelt phonetically in brackets, so that the little student will have no difficulty in learning the pronunciation. Amongst the many fine illustrations in this book, we may single out for special mention that of the Isak Square, St. Petersburg, which is really beautifully drawn and engraved. This volume concludes with a clear explanation of what is meant by latitude and longitude, and of the revolutions of the earth.

Asia, Africa, and America are dealt with in Book VI. Amongst the authors who are drawn upon in this volume are Dean Stanley, Lady Brassey, A. R. Wallace, and Anthony Trollope. The final volume, No. VII., deals to some extent with physical geography and the planetary system, and includes a long series of extracts from 'The Voyage of the *Challenger*.'

We can only conclude by saying that these are models of what geographical readers should be. Criticism might, perhaps, be exercised upon some small details. The sketch which is given of the system of Government in England appears to us, for example, quite inadequate, and we think it would have been better to omit this topic altogether, rather than to have treated it in a manner so perfunctory as to be extremely likely to mislead. Taking the books as a whole, it would be difficult to give them praise which should exaggerate their merits.

A Practical and Philological Text-Book on the Analysis of Sentences, Parsing, and Punctuation. Specially adapted for the use of Schools and Colleges. By John J. Jones. London: Longmans, Green and Co.

There is, perhaps, no subject of English instruction on which a greater number of text-books have been written than on grammar. From large and costly folio volumes, down to penny 'Standard Grammars,' there is a bewildering choice, of varying degrees of excellence, and of great diversity of plan. The writer who adds another to the list ought surely to have something special to say, either as to the matter itself, or to its mode of treatment. And this much may be fairly conceded at once to the author of the book before us. It is an elaborate and very carefully-written treatise, divided into four chapters, which treat successively of Simple Sentences, Complex Sentences, Compound Sentences, and Punctuation, followed by an Appendix which deals with the Structure of the Verb, and the Structure of the Predicate. It is intended for somewhat advanced scholars, the pupil being 'supposed to be able to parse tolerably well before he enters upon the study of this Text-Book.' This may explain, if it do not altogether justify, the somewhat difficult style of expression and choice of words employed in many of the Definitions, and the Directions to the Pupil. Thus, among Preliminary Explanations, in Paragraph 1 is this: 'To analyse a sentence is to break it up into its constituent and compound elements.' One of the first directions given to the scholar is, 'Analyse the appended examples as per Plan I.' Such words and phrases make considerable demand on the knowledge and intelligence of an average schoolboy, at the stage at which the analysis of sentences is usually begun. There is no lack of clearness in the author's style when once the words are understood; and, doubtless, the teacher using the book is expected to give the necessary explanations. But simpler language would be an advantage to teacher and learner, and would detract nothing from the excellence of the book, but would the rather add to its value.

The structure of English sentences, from the simplest to the most complex, is minutely detailed in the order indicated above. The plan adopted is to illustrate and explain each successive element, and the mode of its analysis, in due order. This is followed by a series of examples to be treated by the pupil after the pattern set by the teacher, and these again by 'Lessons,' to be worked as examination papers. A feature of special excellence is the choice and gradation of examples. We have nowhere seen anything equal to these, for number, variety, and admirable adaptation to their purpose. Out of the hundreds of sentences selected as examples, we notice none that are not good in themselves, and well adapted for their purpose. The simplest are not silly, while among the more advanced are some of the choicest expressions, both of thought and of style, which the language affords. The works of many of the best writers of English have been laid under contribution. A list of the authors, specimens of whose style furnish the illustrations and examples, would comprise the names of many of the foremost literary Englishmen, from Chaucer to the present day. The labour of selecting these examples must have been great, and it is labour well applied.

'Following each successive stage of analysis, instruction is given in Parsing' This seems to us to be the only true method of teaching Parsing, for, as is well shown by the author, both analysis and parsing depend, for their clear understanding, upon 'the different functions of words and their mutual bearing.' Complete and careful instruction is given on the relation of these two parts of grammar to each other. Idiomatic difficulties are explained in great detail, and every part of the subject is dealt with in an able and scholarly manner.

The chapter on Punctuation, that too-sadly neglected element of style, is most valuable. All the 'marks used for punctuation and for various other purposes' are given, and are fully dealt with, both by way of explanation and illustration. Common errors are pointed out, and an abundant series of examples furnished for illustration and for practice.

The Appendix, dealing with the Structure of the Verb and of the Predicate, the author introduces with the remark that it contains 'matter too abstruse for ordinary school purposes, and, in a few instances, dwells upon points that must be considered debatable ground.' He speaks of what he here advances as 'the offspring of many years' patient study,' and he deprecates 'hasty criticism,' or 'too ready condemnation' of what may at first appear to be unwarrantable.

Into this debatable ground we will not enter. In it will be found a careful discussion of the conjugation of the English Verb, including a defence of the Potential Mood, which has been so summarily set aside by some recent grammarians, and an elaborate exposition of Voice, Tense, and Mood, with their bearing on intricate and misunderstood points of idiom and of style. This, at least, may be said, that no opinion is advanced by the author which is not sustained by sound argument and sensible exposition.

We heartily commend this work to the careful perusal of teachers who desire for their pupils a clear and intelligent presentation of the structure and functions of our noble English speech.

The book has been carefully edited, and overlooked errors are few. An unfortunate example of one, however, is to be found on page 176, in the quotation from the ninth chapter of St. John's Gospel, where the present indefinite of the subjunctive mood '*be*,' has been substituted for the past indefinite.

Descriptive Botany Tables. By C. H. Octavius Curtis. Lymington: H. Doman.

This is a remarkably clear and accurate tabular guide to the description and classification of plants.

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A Summary of English History. Designed for the Use of Schools. By Llewellyn C. Burt, Barrister. London: Simpkin, Marshall, and Co.

Of the various methods of teaching history, followed by writers of text-books on the subject, two are chief. One is by giving a general knowledge of the story of the past by vivid, interesting narration and description, utilizing the ready eagerness common to young and old of listening to good 'story-telling'; then helping the memory by short summaries of selected and arranged dates, names, and events. The other is by presenting first the bare, disjointed outline of 'facts' to be committed to memory, and clothing them with details afterwards, if at all.

There is no lack of books of both kinds. Those teachers who prefer the latter method will find this little book convenient for their purpose. Here is a skeleton of English history, fairly complete, compact, and necessarily 'dry.' It has the usual features of such summaries: chronological arrangement of the principal facts; tables of the genealogies of the several royal houses, somewhat pedantically spoken of as 'Regnal Tables'; special paragraphs of notes, describing important matters, as the Habeas Corpus Act, the Magna Charta, House of Commons, etc., and also brief accounts of eminent persons, under the heading, 'Names of Note.'

It is claimed as 'the distinctive feature of these Tables' that 'each reign is, with a few exceptions, divided into a *uniform number of sections* (*four*). By this means it is believed that the memory of the pupil will be greatly assisted.' Probably it will. But it involves the very doubtful advantage of equalising the space, and the number of events, in reigns of such diverse length and importance as those of Henry III. (fifty-six years) and Richard III. (two years); in the comparatively uneventful reign of Edward II. (twenty years), and the more stirring times of his father, Edward I. (thirty-five years), and of his son, Edward III. (fifty years); and it finds four sections, neither more nor less, for each of the reigns of Henry VIII. (thirty-eight years), of his son Edward (six years), and his daughters Mary and Elizabeth (five, and forty-five years, respectively). It is inevitable that such an arrangement must bring into prominence some events of small moment, and omit many of great importance.

The value of such books necessarily depends greatly on the method in which they are used. If children 'at an early age,' to quote from the preface, are required, as an approach to the study of history, to commit to memory the dry and detached details contained in the pages of this book, the probability is that many will suffer the great educational evil of acquiring a permanent dislike to the records of the past. But if those records be presented to them in language and style suited to their age and capacity, and with something of the picturesqueness of Mr. Green's 'Shorter History of the English People,' and this book be afterwards used to give definiteness and precision to the order and relative position of the facts, it will serve a useful purpose.

The book is one of the best of its kind, albeit the kind is one that eminently favours that bane of teaching in the present day—cramming for examinations.

Notes of a Course of Lectures on Commercial Geography. By the Rev. L. C. Casartelli, M.A., Professor of Commercial History and Geography in St. Bede's College, Manchester. Manchester: J. B. Ledsham.

This is an excellent book in all respects, both as a manual for the teacher and a book of reference. The subject is one of the highest practical value in a trading community such as ours, and its treatment in this little work, of less than 120 pages, is highly satisfactory.

These most carefully compiled 'Notes' were drawn up by the author for his use in preparing classes for the examinations in Commercial Geography and History, instituted some years ago by the Lancashire and Cheshire Union of Institutes. The best works on the subject, German, French, as well as English, have been laid under contribution, and the result is an admirable compendium of information on the industries and commerce of all the trading countries of the world. The matter is compact, and its excellent arrangement in Chapter I., 'The British Isles,' is followed in dealing with other countries so far as the differences in their conditions admit. The several matters treated of are: Population, Climate and Soil, the relation of these to natural products, and consequent Industries in distinct localities, Agriculture, Food and Drink Industries, Mineral Produce and Metal Trade, Hardware, Potteries and Glass, Textile Trades, Ports, and Shipping.

There are valuable chapters on Trade Routes, the Chief Ports of the World, Railways, Canals, and Telegraphic Communication; and Appendices giving 'Our Trade Account' with other countries, and a comparison of the Commercial Statistics of the British Empire with five other commercial nations.

The book is well printed,—paragraphs, headings, and various types, greatly facilitating the clear presentation of the matter.

Altogether this brief epitome of Trade Geography is unique in scope and completeness, and we highly commend it for the actual value of its contents, as well as for its suggestiveness to teachers.

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Publications Received.

Blackie and Son—
An Epitome of History by Carl Ploetz.
Vere Foster's Simple Lessons in Water Colour. Pts. 1, 2, 3, and 4.
Blackie's Geographical Readers. Nos 4, 5, and 6.
A Text-Book of Domestic Economy. By E. Rice.

Cassell and Co., Limited—
Introductory Lessons in Geography. St. I.

Chambers (W. and R.)—
Chambers' Geographical Readers. Standards III. and IV.

Heywood (John)—
The Paragon Reader. St. V.
Graduated Exercises in English Grammar. By M. Hickey.

Letts, Son, and Co., Limited—
Letts' Illustrated Household Magazine. July.

Longmans and Co.—
Longman's Magazine for July.
Macaulay's Essay on Milton. Edited by A. Mackie, M.A.
A Text-Book on Practical Solid or Descriptive Geometry. By D. A. Low.
White's Latin-English and English-Latin Dictionary.

Murby (T.)—
Murby's Scripture Manuals—Judges.

Nelson and Sons—
The New Royal Reader, No. 5.

Relfe Bros.—
A Digest of English History, 1689-1760. By M. Gutteridge, B.A.

Rice (William)—
Oxford and Cambridge Local Examinations in Arithmetic, with Answers, 1858-1883. By R. Oscar T. Thorpe, M.A.

Smith, Elder, and Co.—
Cornhill Magazine. July.

Stewart, W., and Co.—
Outlines of Mental Philosophy. By Dr. Morell.

Swan Sonnenschein and Co.—
Handbook of Agriculture. By R. W. Ewing.
The Logical English Grammar. By F. G. Fleay, M.A.
The Musician—Third Grade. By Ridley Prentice.

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ **When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.**

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Arithmetic.

1. MONITOR.—(1) The true discount on a bill of £83 9s. 6d., due fifteen months hence is £3 19s. 6d.; what is the rate per cent? (2) I receive £3 19s. 6d. as true discount at 4 per cent. on a bill of £83 9s. 6d., when is the bill due? (*All-the-year round Test Cards.*)

(1) Present value of bill = £83 9s. 6d. − £3 19s. 6d.
= £79 10s.;

£ 79½ : £ 100 :: £ s. d. 3 19 6 : Rate per cent.
yrs. yr. 1¼ : 1
20
79
2
159

∴ Rate per cent. = $\frac{\cancel{4}\cancel{0} \times 4 \times \cancel{1}\cancel{5}\cancel{9}}{\cancel{1}\cancel{5}\cancel{9} \times \cancel{5} \times \cancel{4}\cancel{0}}$ = 4. Ans.

(2) Interest for 1 year on present value of bill
= 4 per cent. on £79 10s.
= £3·18:

£ £ s. d. year.
∴ 3·18 : 3 19 6 :: 1 : Time.
year.
3·18 : 3·975 :: 1 : Time.
2 2·5
= 1·25 years
= 15 months. Ans.

2. MAGISTER.—(1) A clock, which loses 10 secs. per hour, is set to the correct time at 9.15 a.m. on Monday. What will be the correct time by the clock, when its hour and minute hand point in exactly opposite directions between 9 and 10 o'clock p.m. in the evening?

(2) How must the hands be altered so that the clock may show the correct time at noon on Tuesday? (*Barnard Smith's* 'Examination Papers in Arithmetic.')

(1) The hands will be exactly opposite between 9 and 10 at (15 + 1/11 of 15) min. past 9
= 16 4/11 min. past 9;
Time from 9.15 a.m. to 9.16 4/11 p.m.
= 12 hrs. 1 4/11 min.
= 12 hrs. 1 min. 21 5/11 sec.;

min. sec. hrs. min. sec. sec.
∴ 59 50 : 12 1 21 5/11 :: 10 : Time lost.
60 60
3590 721
11 60
3949 43281
11
)470100(120 220/3949 secs.
3949
8120
7898
2220

∴ Correct time = (16 4/11 min. + 120 220/3949 sec.) past 9 p.m.
= (16 min. 21 5/11 sec. + 2 min. 0 220/3949 sec.) past 9 p.m.
= 18 min. 22 220/3949 sec. past 9 p.m. Ans.

(2) Time from 9·15 a.m. on Monday to noon on Tuesday = 26¾ hours;

hr. hrs. sec.
∴ 1 : 26¾ :: 10 : Time lost.
10
6,0 | 26,7 sec.
4 min. 27½ sec. Ans.

3. R. W. K.—Show that it is better for a clerk to have his salary increased by £5 a half-year than by £20 a year.

Advantage 1st year = £5;
" 2nd " = (£10 + £15) − £20
= £25 − £20
= £5;

In 1st case there is an increase of £20 annually, and salary for 1st year is £5 higher;
∴ Advantage = £5 yearly.

4. W. H. W.—The discount on £566 10s. for 9 months is £16 10s.; find the rate of interest.

Present worth = £566 10s. − £16 10s.
= £550;

£ £
550 : 100 :: £ 16½ : Rate per cent.
yr. yr.
¾ : 1

∴ Rate per cent. = $\frac{\cancel{2}\cancel{0}\cancel{0} \times 4 \times \cancel{3}\cancel{3}}{\cancel{5}\cancel{5}\cancel{0} \times \cancel{3} \times \cancel{2}}$
= 4. Ans.

5. J. W.—The discount on a certain sum for 2½ years is 20/87 of the interest. What is the rate per cent.?

Interest − Discount = Interest on the Discount;
∴ Interest − 20/87 of Interest = Interest on 20/87 of Interest,
67/87 of Interest = Interest on 20/87 of Interest,
7 times Interest = Interest on 80 times Interest,
Rate per cent. × 2½ × 7 = (Rate per cent. × 2½ × 80)
× Rate per cent. × 2½ / 100
7 = 80 × Rate per cent. / 40
= Twice Rate per cent.,
∴ Rate per cent. = 3½. Ans.

6. SARCOPHAGUS.—An agent has to receive a rent paid in corn from a tenant, and deliver it to the landlord. At each payment he uses, so as to benefit himself, a false balance, such that 9 lbs. in one scale balances 10 lbs. in the other. Corn being worth 49s. a quarter, the value of his plunder is £46 11s. What is the corn-rent? (*Hamblin Smith.*)

Quantity plundered = $\frac{1}{19}$ of whole ;
Quantity of plunder in qrs. = £46 11s. ÷ 49s.
= 931s. ÷ 49s.
= 19 ;
∴ Corn-rent = (19 × 10) qrs.
= 190 qrs. Ans.

7. FOLKESTONIAN.—A young clerk is offered a salary of £50 a year, with his choice of an increase of £2 per quarter, or of £35 per year. Compare the sums total of his earnings at the end of five years, according as he adopts one or the other alternative. (*Pupil Teachers' Examination.*)

		£
First year's salary of first offer	= £(50 + 2 + 4 + 6)	= 62
Second " " "	= £(50 + 8 + 10 + 12 + 14) or £{62 + (8 × 4)}	= 94
Third " " "	= £(50 + 16 + 18 + 20 + 22) or £{94 + (8 × 4)}	= 126
Fourth " " "	= £(50 + 24 + 26 + 28 + 30) or £{126 + (8 × 4)}	= 158
Fifth " " "	= £(50 + 32 + 34 + 36 + 38) or £{158 + (8 × 4)}	= 190
Total salary for 5 years of first offer		= £630
" " " second "	= £[50 × 5 + {35 × (4 + 3 + 2 + 1)}] = £{250 + (35 × 10)} = £(250 + 350)	= 600

∴ Difference = £30

8. SUSIE.—A person has ·1875 part of a mine ; he sells ·1$\dot{7}$ part of his share ; what fractional part of the mine has he still left ? (*Barnard Smith.*)

He has ·1875 = $\frac{3}{16}$ part of the mine ;
He sells ·1$\dot{7}$ = $\frac{1}{6}$ = $\frac{5}{15}$ part of his share ;
∴ He has left $\frac{37}{45}$ of $\frac{3}{16}$ = $\frac{37}{240}$ part of the mine. Ans.

Note.—Perhaps 70 per cent. Your writing lacks regularity.

9. YORKSHIREMAN.—A person has £1475 in the 3 per cents. at 83$\frac{1}{3}$. When the funds have fallen 2$\frac{1}{2}$ per cent., he transfers his capital into the 5 per cents. at 108. Find the alteration in his income.

Income in 1st case = 3% on £1475
= £44 5s. ;

$\frac{£}{\frac{250}{3}}$: $\frac{£}{\frac{81}{4}}$ :: £1475 : Stock in 2nd case.

4 | 3 | 3
4 | 4425
£1106$\frac{1}{4}$

Income in 2nd case = 5% on £1106$\frac{1}{4}$
= £55 6s. 3d. ;
∴ Alteration in income = (£55 6s. 3d. − £44 5s.) increase
= £11 1s. 3d. increase. Ans.

10. WELSHMAN.—A invests £4625 in railway stock at 125 ; B invests £4900 in another at 120. A receives an annual dividend at the rate of 4$\frac{1}{2}$ per cent., and receives £3 10s. more than B. At what rate was the annual dividend to B calculated ? (*Certificate*, 1881.)

A's dividend = $(\frac{4625}{125} \times 4\frac{1}{2})$£
= $\frac{37 \times 17}{4}$£
= $\frac{629}{4}$£
= £157 5s. ;
B's " = £157 5s. − £3 10s.
= £153 15s. ;
∴ Annual dividend of B's stock
= $(153\frac{3}{4} \times \frac{100}{4900})$ per cent.
= $\frac{615}{4 \times 49}$ per cent.
= $\frac{15}{49}$ per cent.
= 3$\frac{3}{4}$ per cent. Ans.

11. ROGO.—What is the least number which if divided by 43 and multiplied by 41 will leave 18 for a remainder ?

Difference between 43 and 41 = 2 ;
For No. 1 the remainder = 41 ;
For remainder 9, Least No. = {(41 − 9) ÷ 2} + 1
= 16 + 1
= 17 ;
∴ " 18, " = 17 × 2
= 34. Ans.

12. J. EDWARDS.—A vessel making for a harbour fires a signal gun ; the flash is seen from the harbour, and the sound follows in 22$\frac{1}{2}$ sec. ; a tug puts off at once and steams straight to the vessel at 12 miles an hour, and from the vessel 5 min. afterwards, the flash of a second gun is seen, the sound of which follows in 15 sec. If sound travels 13 miles per minute, at what rate is the vessel approaching the harbour, and how soon after starting will the tug meet her ? (*Lower Division*, October, 1883.)

Distance of vessel from harbour when first gun is fired
= 13 miles × $\frac{22\frac{1}{2}}{60}$
= $\left(13 \times \frac{45}{120}\right)$ miles
= $4\frac{7}{8}$ miles ;
Distance of vessel from tug when second gun is fired
= 13 miles × $\frac{1}{4}\frac{5}{0}$
= $3\frac{1}{4}$ miles ;
∴ Distance gone by vessel in 5 min. = $\{4\frac{7}{8} - (3\frac{1}{4} + 1)\}$ miles
= $\frac{5}{8}$ mile ;
∴ Rate of vessel = ($\frac{5}{8}$ × 12) miles per hour
= 7$\frac{1}{2}$ miles per hour. Ans.

∴ The tug will meet the vessel in

$\frac{4\frac{7}{8}}{7\frac{1}{2} + 12}$ of an hour
= $\frac{4\frac{7}{8}}{19\frac{1}{2}}$ of an hour
= $\left(\frac{39}{8} \times \frac{2}{39}\right)$ of an hour
= $\frac{1}{4}$ hour
= 15 min. Ans.

13. MONSTER.—A man walking forward on a ship, steaming with the tide, has an absolute motion of a mile in 3$\frac{1}{3}$ min. ; if the tide were running the other way, his absolute motion would be a mile in 6 min. ; while if in this latter case he turned and walked towards the stern, his absolute motion would be a backward one, at a mile in 30 min. Find rate per hour of walking, steaming, and of the tide.

Absolute rate per hour in first case = $\frac{60}{3\frac{1}{3}}$ miles
= 18 miles ;
" " second " = $\frac{60}{6}$ miles
= 10 miles ;
" " third " = $\frac{60}{30}$ miles
= 2 miles ;

Rate of walking + Rate of steaming + Rate of tide = 18 miles
Rate of walking + Rate of steaming − Rate of tide = 10 miles

Subtracting, Twice Rate of tide = 8 miles,
∴ Rate of tide per hour = 4 miles.

Rate of steaming + Rate of walking + Rate of tide = 18 miles
Rate of steaming − Rate of walking − Rate of tide = 2 miles

Adding, Twice Rate of steaming = 20 miles,
∴ Rate of steaming per hour = 10 miles.

∴ Rate of walking per hour = 18 miles − (10 + 4) miles
= 4 miles.

14. HOPEFUL.—A baker fixes the price of a quartern loaf, when the cost of converting wheat into bread is 5 per cent. on the cost of the wheat, with a view to gaining 20 per cent. on the cost of his bread. Show that if wheat falls 16 per cent., and the cost of converting it into bread rises 20 per cent., he ought to sell seven loaves for the price at which he before sold six, and that if he does not alter his price, he will gain on his outlay 40 per cent. instead of 20 per cent.

Cost of converting the wheat into bread in the first case = $\frac{1}{2}\frac{5}{0}$ or $\frac{1}{20}$ of original cost of wheat ;

∴ Cost-price of bread in first case $= \frac{3}{10}$ of original cost of wheat;

Selling " " " $= \left(\frac{21}{\cancel{20}} \times \frac{\cancel{120}^{3}}{\cancel{100}} \right)$ " "

$= \frac{63}{50}$ " " ;

Cost of converting the wheat into bread in the second case

$= \left(\frac{1}{\cancel{20}} \times \frac{\cancel{120}^{3}}{\cancel{100}}\right)$ of original cost of wheat

$= \frac{3}{50}$ " " " ;

∴ Cost-price of bread in second case

$= \left(\frac{100-16}{100} + \frac{3}{50}\right)$ of original cost of wheat

$= \frac{42+3}{50}$ " " "

$= \frac{9}{10}$ " " " ;

∴ Price of loaf in first case : Price of loaf in second case

:: $\frac{11}{10}$: $\frac{9}{10}$,

:: 21 : 18,

:: 7 : 6;

∴ He ought to sell seven loaves for the price at which he before sold six.

Gain in second case if selling-price is unaltered

$= (\frac{63}{50} - \frac{9}{10})$ of original cost of wheat

$= \frac{63-45}{50}$ " " "

$= \frac{9}{25}$ " " " ;

∴ $\frac{9}{10}$: 100 :: $\frac{9}{25}$: Gain per cent.

∴ Gain per cent. $= \frac{\cancel{100}^{4}}{1} \times \frac{9}{\cancel{25}} \times \frac{10}{9}$

$= 40.$

15. SPES.—The paper duty was 1½d. per lb.; the duty on playing cards 1s. per pack. Three packs of playing-cards weigh 1 lb. The paper manufacturer gains 20 per cent. on his outlay; the maker of the cards 20 per cent. on his sale. The former duty has been abolished, and the latter reduced to 3d. Show that the price of cards might be reduced 1s. a pack, allowing each tradesman the same rate of profit as before.

Paper duty on a pack of cards was ½d.

Cost for duty to maker of cards $= 1s. + \left(\frac{1}{2}d. \times \frac{\cancel{120}^{6}}{\cancel{100}}\right)$

$= 1s. + \frac{3}{5}d.$

$= 12\frac{3}{5}d.$;

" " buyer " $= 12\frac{3}{5}d. \times \frac{100}{100-20}$

$= \left(\frac{63}{\cancel{5}} \times \frac{\cancel{100}^{\cancel{5}}}{\cancel{80}}\right)d.$

$= 15\frac{3}{4}d.$;

Cost for duty to buyer of cards after reduction

$= 3d. \times \frac{100}{80}$

$= 3\frac{3}{4}d.$;

∴ Difference between the two prices $= 15\frac{3}{4}d. - 3\frac{3}{4}d.$

$= 1s.$

Geometry.

1. SUDBURY.—ABC is a triangle, and the exterior angles at B and C are bisected by the straight lines BD, CD respectively, meeting at D; show that the angle BDC together with half the angle BAC make up a right angle. (*Todhunter.*)

Produce AB to any point F, and AC to any point G. Bisect angles GBF, BCG by the straight lines BD, CD, meeting at D.

Bisect the angles ABC, ACB by the straight lines BE, CE, meeting at E.

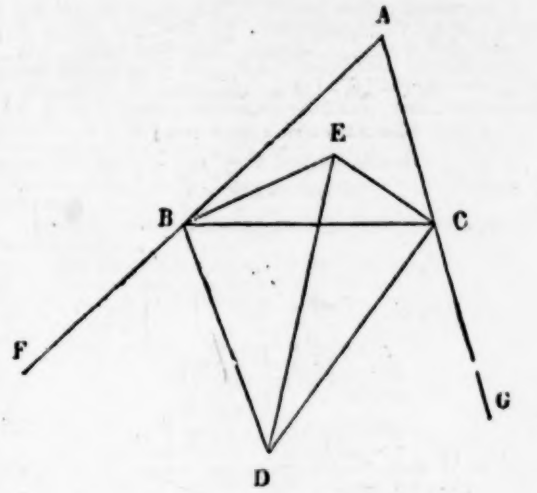
Join ED.

Proof.—∠ EBC = Half ∠ ABC,

∠ DBC = " ∠ FBC,

∴ ∠ EBD = " ∠s ABC, FBC

= half of 2 right angles; (I. 13.)



Wherefore ∠ EBD is a right angle;

Similarly it can be proved that ∠ ECD is a right angle.

Again, ∠s BEC, EBC, ECB = 2 right angles, (I. 32.)

∴ ∠ BEC together with ½ ∠ ABC and ½ ∠ ACB = 2 right angles;

∠ EBD is a right angle,

∴ ∠s BED, EDB = a right angle (I. 32.)

Wherefore ∠s BEC, BDC are together equal to two right angles;

∴ ∠s BEC, BDC = ∠s BEC, ½ ∠ ABC, ½ ∠ ACB,

Wherefore, ∠ BDC = ½ ∠ ABC, ½ ∠ ACB,

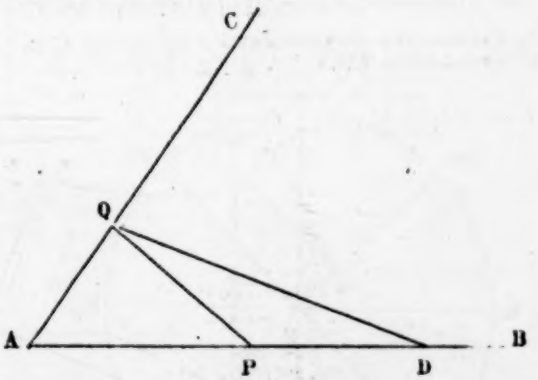
Add ½ ∠ BAC to each;

∴ ∠ BDC + ½ ∠ BAC = ½ ∠ ABC, ½ ∠ ACB, ½ ∠ BAC

= ½ of two right angles

= a right angle. Q. E. D.

2. BONA FIDE.—AB, AC, are two straight lines given in position; it is required to find in them two points P and Q, such that, PQ being joined, AP and PQ may together be equal to a given straight line, and may contain an angle equal to a given angle. (*Todhunter.*)



From AB cut off AD equal to the given straight line. (I. 3.)

At the point D draw DQ making the angle ADQ equal to half the given angle, and meeting AC in Q.

At the point Q draw QP, on the same side of QD as DA, making the angle QPD equal to the angle QDP, and meeting AB in P.

Proof.—∠ PDQ = ∠ PQD (Con.)

∴ PQ = PD; (I. 6.)

Wherefore AP and PQ = AD

= the given straight line,

Again, $\angle APQ = \angle$ sPQD, PDQ (I. 32.)
$= $ Twice $\angle PDQ$
$= $ Given angle. Q. E. F.

Note.—We believe paragraph A would obtain most marks.

3. BOLDMERE.—Show how to divide a straight line into two parts, such that the rectangle under the whole line and one of the parts shall be equal to the square on the other part.

Show from the construction that the parts of the divided line are to each other as $\sqrt{5}-1$ to $3-\sqrt{5}$. What is the simplest form of this ratio? (*2nd Stage Mathematics*, 1884.)

Let AB contain a linear units;

Then $AC = a$, and $AE = \frac{a}{2}$;

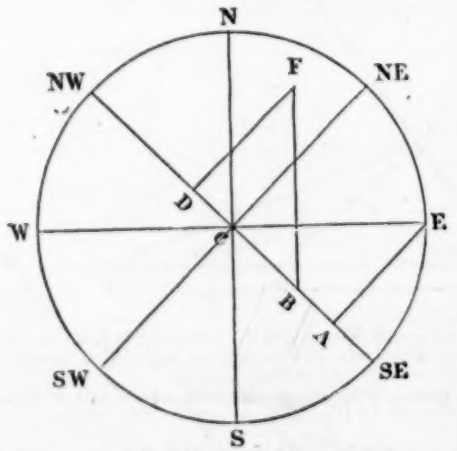
$$EB^2 = AB^2 + AE^2$$
$$= a^2 + \left(\frac{a}{2}\right)^2$$
$$= a^2 + \frac{a^2}{4}$$
$$= \frac{5a^2}{4}$$
$$\therefore EB = \frac{a\sqrt{5}}{2};$$
$$EF = EB = \frac{a\sqrt{5}}{2};$$
$$AF = EF - AE$$
$$= \frac{a\sqrt{5}}{2} - \frac{a}{2}$$
$$= \frac{a(\sqrt{5}-1)}{2}$$

But $AH = AF = \frac{a(\sqrt{5}-1)}{2}$;

$$HB = AB - AH$$
$$= a - \frac{a(\sqrt{5}-1)}{2}$$
$$= \frac{2a - a\sqrt{5} + a}{2}$$
$$= \frac{a(3-\sqrt{5})}{2};$$
$$\therefore AH : HB :: \frac{a(\sqrt{5}-1)}{2} : \frac{a(3-\sqrt{5})}{2},$$
$$:: \sqrt{5}-1 : 3-\sqrt{5},$$
$$:: (\sqrt{5}-1)(\sqrt{5}+1) : (3-\sqrt{5})(\sqrt{5}+1),$$
$$:: (5-1) : 2\sqrt{5}-2,$$
$$:: 4 : 2(\sqrt{5}-1),$$
$$:: 2 : \sqrt{5}-1.$$

Note.—Perhaps full percentage of marks for your writing.

4. CASSIVELLAUNUS.—I am walking along a straight beach which stretches from N.W. to S.E. At 9.35 a.m. I notice a black



buoy to the N.E. At 9.43 a.m. I see a red buoy due N. of me. At 10 a.m. the black buoy is due E. of me, and at 10.8 a.m. I see the red buoy to the N.E. Compare the distances of the buoys from the shore, I having walked all the time at the same rate.

Let A be my position at 9.35 a.m., B at 9.43 a.m., C at 10 a.m., and D at 10.8 a.m. Draw AE parallel to the line to the N.E., BF parallel to the line to the N., and DF parallel to the line to the N.E.

Then, E denotes the position of the black buoy, and F the position of the red buoy.

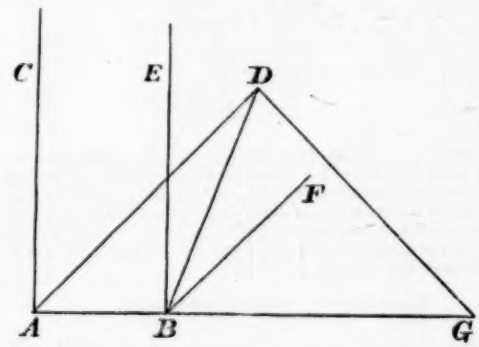
AC represents distance walked from 9.35 a.m. to 10 a.m., that is, in 25 minutes;

BD represents the distance walked from 9.43 a.m. to 10.8 a.m., that is, in 25 minutes;

$\therefore$ AC = BD.

In the triangles AEC, DFB,
$\angle EAC = \angle FDB$, (Ax. 11.)
And $\angle ECA = \angle FBD$,
As $\angle ECA = \frac{1}{2}$ Right Angle,
And $\angle FBD = \angle$ between the lines to the N. and N.W.
$= \frac{1}{2}$ Right Angle;
And side AC = side BD;
$\therefore$ side AE = side DF. (I. 26.)
Therefore the buoys are at the same distance from the shore.

5. CORWISI.—Produce a given straight line so that the square on the whole line thus produced may be double the square on the part produced.



Let AB be the given straight line.

At A draw AC at right angles to AB, and bisect the angle BAC by the straight line AD.

Draw BE parallel to AC, and BF parallel to AD.

Bisect the angle EBF by the straight line BD, meeting AD in D.

At the point D draw DG at right angles to AD, meeting AB produced in G.

Then the square on AG shall be double the square on BG.

Proof.— $\angle$ EBG is a right angle,
and $\angle$ EBD is $\frac{1}{4}$ of a right angle,
$\therefore$ $\angle$ DBG is $\frac{3}{4}$ " " " ;
$\angle$ DBG = $\angle$s BAD, ADB, (I. 32.)
and $\angle$ BAD is $\frac{1}{2}$ of a right angle,
$\therefore$ $\angle$ ABD is $\frac{1}{4}$ " " " ;
$\angle$ ADG is a right angle,
$\therefore$ $\angle$ BDG is $\frac{3}{4}$ of a right angle;
Wherefore BG = DG. (I. 6.)
Again, $\angle$ ADG is a right angle,
and $\angle$ DAG is $\frac{1}{2}$ of a right angle,
$\therefore$ $\angle$ DGA is $\frac{1}{2}$ " " " ; (I. 32.)
Wherefore AD = DG.
$AG^2 = AD^2 + DG^2$, (I. 47.)
$= 2DG^2$
$= 2BG^2$. Q. E. F.

Note.—Each correspondent is restricted to *one* question. Please send the arithmetical query you wish to be solved next month and the answer.

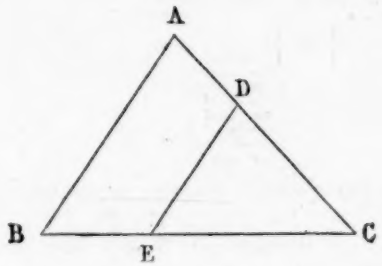
Mensuration.

1. E. COUMBE.—The external length, breadth, and height of a rectangular wooden closed box are 18, 10, and 6 in. respectively, and the thickness of the wood is $\frac{1}{2}$ in. When the box is empty it weighs 15 lbs., and when filled with sand 100 lbs. Compare weights of equal bulks of wood and sand. (*Brook Smith.*)

Weight of box $= [(18 \times 10 \times \frac{1}{2} \times 2) + \{18 \times (6-1) \times \frac{1}{2} \times 2\} + \{(10-1) \times (6-1) \times \frac{1}{2} \times 2\}]$ cub. in.
$= (180 + 90 + 45)$ cub. in.
$= 315$ cub. in.;
Internal content of box $= \{(18-1) \times (10-1) \times (6-1)\}$ cub. in.
$= (17 \times 9 \times 5)$ cub. in.
$= 765$ cub. in.;

$\therefore$ Wood : Sand :: $\left(\frac{\cancel{3}\cancel{1}\cancel{5}}{\cancel{3}\cancel{1}\cancel{5}} \times \frac{765}{315}\right)$ lbs. : $(100-15)$ lbs.
$\frac{255}{21}$
$\frac{7}{}$
:: $\frac{255}{7}$: 85,
:: $\frac{85}{7}$: 1,
:: 3 : 7.

2. POMPEY.—The side AB of a triangular field is 40, BC 30, and CA 25 chains. Required the size of the sides of a triangle parted off by a division fence made parallel to AB, and proceeding from a point in CA at the distance of 9 chains from the angle A.



CD = CA − AD
$= (25-9)$ chains
$= 16$ chains;
CE : CB :: CD : CA,
CE : 30 :: 16 : 25,

$\therefore CE = \frac{\cancel{30} \times 16}{\cancel{25}}$ chains
$= \frac{96}{5}$ chains
$= 19{\cdot}2$ chains;

DE : AB :: CD : CA,
DE : 40 :: 16 : 25,

$\therefore DE = \frac{\cancel{40} \times 16}{\cancel{25}}$ chains
$= \frac{128}{5}$ chains
$= 25{\cdot}6$ chains.

3. F. G. JACKSON.—A garden is 100 ft. long and 80 ft. broad. A walk of equal width is made all round it; find the width, so that it takes up just half the ground.

Area of walk $= \frac{100 \times 80}{2}$ sq. ft.
$= 4000$ sq. ft;
But, area of walk $= [2(100 + 80 - \text{twice width}) \times \text{width}]$ sq. ft.
$= \{(360 - 4 \text{ times width}) \times \text{width}\}$ sq. ft.
$= (360 \text{ times width} - 4 \text{ times width}^2)$ sq. ft.;

$\therefore$ 360 times width − 4 times width^2 = 4000
4 times width^2 − 360 times width = − 4000
Width^2 − 90 times width = − 1000
Width^2 − 90 times width + $(45)^2$ = 2025 − 1000 = 1025
Width − 45 = $\pm$ 32·01562...
$\therefore$ Width = $\pm$ 32·01562... + 45
= 77·01562..., or 12·9843...

It is evident that the value 77·01562... is inapplicable.
$\therefore$ Width of walk = 12·9843 .. ft.

Note.—See No. 9 (Arithmetic) in our issue for February, 1884, for the other query.

4. M. R. S.—A rectangular parish 6 fur. long and 4 fur. broad is enclosed; a belt of plantation 200 feet wide is carried the whole way round; a main road 60 feet wide runs across the land in the direction of its length, and a cross road 41 feet wide in the direction of its breadth; how many acres of field were there? (*Colenso.*)

There are four equal rectangular parts of field, the dimensions of which are
$[(6 \times 220)$ yds. $- \{(200 \times 2) + 41\}$ ft.$] \div 2$, and
$[(4 \times 220)$ yds. $- \{(200 \times 2) + 60\}$ ft.$] \div 2$;

$\therefore$ Part field $= \frac{1320 - 147}{2}$ yds. $\times \frac{880 - 460}{2}$ yds. $\times 4$
$= \left(\frac{\cancel{391}\cancel{1173}}{\cancel{2}} \times \frac{1090}{\cancel{2}} \times \frac{\cancel{4}}{1}\right)$ sq. yds,
$= 852{,}380$ sq. yds.
$= 176$ ac. 540 sq. yds. Ans.

General.

1. J. P.—'Epochs of English History' (Longmans and Co.); 'Modern England,' and the preceding volume 1s. each. 'The Nineteenth Century,' by *Mackenzie* (Nelson); Abridgment of 'History of our Own Times,' by *J. McCarthy*, 6s. (Chatto and Windus.)

2. R. ALLEN.—80.

3. HUNTINGDON :—

Sentence.	Kind.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) They stood aloof, the scars remaining like cliffs	P. S.		they	stood		aloof, the scars remaining like cliffs (man.)
(*b*) Which had been rent asunder	Adj. to *cliffs* in *a*	*Invel. pro.*	which	had been rent		asunder
(*c*) A dreary sea now flows between	P.S.		A dreary sea	flows		between (place) now (time)
(*d*) But I ween	P.S. Adv. to *c*	but	I	ween		
(*e*) Neither heat shall wholly do away the marks of that	Noun sent. to *d*	neither	heat	shall do away = destroy	the marks of that	wholly (deg.)
(*f*) Nor frost	*do.*	nor	frost	[shall do, etc.]	,,	
(*g*) Nor thunder	*do.*	nor	thunder	[shall do, etc.]	,,	
(*h*) Which hath been once.	Adj. sent. to *that* in *e*		which	hath been		once

4. EMERALD.—The two expressions do *not* coincide.

5. IMPORTUNATE.—The solution of your query appeared in our issue for June, 1883.

6. PUZZLED.—You will find the solution of your query in our issue for April, 1882.

7. X. Y. Z.—Your query was solved in our issue for February, 1882.

8. FRED.—If the well be bell-shaped, the depth at which the sides diverge must be given, otherwise the solidity cannot be ascertained. The volumes of the cylinder and the frustrum of the cone could then be found.

Volume of cylinder $= a^2 h$;

" frustrum of cone $= \frac{h}{3}(a^2 + ab + b^2)$;

where, a^2 and b^2 are the areas of the two ends, and h is the height.

9. D. V.—*Dickinson's* 'History of the English Language,' price 3d. (Hughes).

10. GUV'NOR.—70.

11. FELIX.—Apply for permission to sit, and if your inspector recommends you, you will receive notice when to attend. Writing, 80 per cent.

12. PICCIOLA.—A sort of translation is published by Warne and Co. Writing is good; small hand especially. 90.

13. W. E. MILTON.—Hour, honour, heir, honesty, hostler, and their derivatives. Twenty one thousand four hundred and eight millions, etc., is the safest way to write it; the meaning of the word billion is not settled.

14. DAUNTLESS.—Yes.

15. LUDWIG.—(*a*) Thick, badly formed letters; (*b*) not quite so thick and a little better formed, both very moderate. (*a*) 50, (*b*) 55. The book you name is not bad; we should prefer *Smith's*, Part I., or *Macmillan's* Progressive Course.

16. ROBERT STEPHENSON.—See any of the 'Guides to the Civil Service.' The writing is wretched, and could hardly be worse for the purpose you name.

17. MARMER.—The copying is clear and neat. The writing shows promise, and with practice may develop into a capital hand. The chief fault is want of finish; the letters are often rough and uneven, and the curves badly formed.

18. H. N. W.—

Sentence.	Kind of Sentence.	Conn.	Subject.	Predicate.	Object.	Ext. of Pred.
(*a*) He spake	Princ. S.		He	spake		
(*b*) and Enid easily believed	Princ. S. *co-ord. with* (*a*)	and	Enid	believed		easily like
(*c*) Simple, noble natures, credulous of (that) (believe)	Adv. Sent. to (*b*)		simple, noble natures credulous of (that)	(believe)		
(*d*) they long-for what, good in friend or foe, there most in those	Adj. Sent. to (*c*)		they	long-for	what, good in friend or foe there most in those	
(*e*) who most have done them ill	Adj. Sent. to (*d*)		who	have done	them ill	most

—Writing legible, down strokes rough and uneven, curves need special attention.

19. R. R. P.—The large hand is good. In the small hand the letters and the strokes should conform to the general usage. The words are short, and consist of nearly the same letters. See rules for the Query Column.

20. AGGIE.—The writing is poor, but it is better than the composition. Get a good copy-book and practise.

21. L. D. C.—75.

22. CICERO.—Bold, legible, and promising; careful imitation of a few good copies would improve it.

23. CIVIL SERVICE INQUIRER.—Repeat your question, and say where it can be found. What you have written this time was certainly never set anywhere by anybody; it is unintelligible and ungrammatical.

24. MATRICULATION.—If you take Second Year's Papers and pass in the first class you may succeed. Take two years. Write again after Christmas.

25. A REGULAR SUBSCRIBER.—The name is W. G. Rushbrooke. The book is *printed* at the Clarendon Press, Oxford, and *published* for the university by Macmillan and Co. Refer to the end of your book.

26. FLOWER.—

Sentence.	Kind of Sentence.	Subject.	Predicate.	Object.	Exten.
(*a*) Thou count life a stage upon thy way	Princ. S.	Thou	count	life a stage upon thy way (*factitive* obj.)	
(*b*) Thou follow conscience	Princ. S. *co ord.* with (*a*)	(thou)	follow	conscience	
(*c*) what may come	Adj. Sen. to (*d*)	which	may (come)		
(*d*) Although it come	Adv. S.	that	should come	it	
(*e*) (thou) fear God	Princ. S.	Thou alike with heaven and earth, sincere, with hand, and brow, and bosom clear, with	fear	God	
(*f*) know no other fear	Princ. S.	(Thou)	know	no other fear	

27. J. W. KING, Harrogate.—(1) No. You will be quite safe in using the questions.

(2) Don't use the words of an author who has not been dead forty years without written permission. Insert the name of author at the end of each extract.

28. J. EMERY.—(1) Your query in Algebra was solved in our issue for June, 1884.

(2) Examples:—Pharaoh dreamed a dream. He ran a race. They fought a good fight. (They are called the Cognate Objective.)

(3) Perhaps full marks. It is rather *too thick*.

29. P. T.—(1) To find Principal:—

Simple Proportion.

Amount of £100 for the given time at the given rate per cent. : Given Amount :: £100 : Principal.

(2) To find Rate Per Cent.:—

Compound Proportion.

$$\left.\begin{array}{l}\text{Principal} : \frac{£}{\text{year}}\ 100 \\ \text{Given time} : 1\end{array}\right\} :: \text{Interest} : \text{Rate per cent.}$$

(3) To find Time:—

Simple Proportion.

Interest on Principal for 1 year : Total Interest :: 1 year : Time.

30. H. MEAD.—(1) Thanks for your communication.
(2) The answer to O. 5. in Ex. 62 should be £179 18s. $5\frac{1}{4}$d.
(3) The answer to E. 2. in Ex. 67 should be $121\frac{23}{32}$ lbs.
(4) Ex. 97, C. 3. Any two decimals whose difference is '25 satisfy the condition, as $\cdot25 + (\cdot025 \times 2) = \cdot3$. The question is, therefore, incorrect.

31 CORRESPONDENT.—The fifth, seventh, and any other roots of numbers can be easily determined by Logarithms.

32. SCIENCE.—A railway truck weighs 12 tons; it is drawn from rest by a horse through a distance of 50 feet, and is then

moving at the rate of 3 miles per hour; if the resistances are 8 lbs. per ton, how many units of work must the horse have done on the truck?

No. of units of work done by the horse

$$= \left\{ \frac{\text{Weight of truck in lbs.}}{2g} \times (\text{Velocity per sec. in ft.})^2 \right\} + (\text{Resistance per ton} \times \text{No. of tons} \times \text{Space in ft.})$$

$$= \left\{ \frac{\overset{2}{\cancel{4}} \times 20 \times 112}{\underset{10\cdot73}{\cancel{2} \times \cancel{2}\cdot\cancel{1}\cdot\cancel{1}\cdot\cancel{9}}} \times \left(\frac{\overset{22}{\cancel{3}\cancel{3}} \times \overset{4}{\cancel{8}\cancel{8}} \times \overset{5}{\cancel{8}\cancel{8}}}{\underset{5}{\cancel{6}\cancel{0}} \times \underset{\cancel{5}}{\cancel{8}\cancel{8}}} \right)^2 \right\} + (8 \times 12 \times 50)$$

$$= \left\{ \frac{4480}{10\cdot73} \times (\tfrac{22}{5})^2 \right\} + 4,800$$

$$= \frac{896 \times 484}{10\cdot73 \times 5} + 4,800$$

$$= \frac{433664}{53\cdot65} + 4,800$$

$$= 8,083 + 4,800$$

$$= 12,883. \quad \text{Ans.}$$

33.—A TEACHER.—Managers have a limited right, but the Education Department is the sole judge of the reasonableness of the dismissal. The grant may be endangered if children are improperly excluded from school, but any fair case would undoubtedly be upheld by the Department.

Algebra.

1. PRIAM.—Solve:—

(1) $\dfrac{x+\sqrt{12a^2-x}}{x-\sqrt{12a^2-x}} = \dfrac{a+1}{a-1}$.

(2) $x^3+3ax^2=4a^3$.

(3) $\dfrac{x+\sqrt{x^2-1}}{x-\sqrt{x^2-1}} - \dfrac{x-\sqrt{x^2-1}}{x+\sqrt{x^2-1}} = 8\sqrt{x^2-1}$.

(*Todhunter's* 'Algebra for Beginners.')

(1) $\dfrac{x+\sqrt{12a^2-x}}{x-\sqrt{12a^2-x}} = \dfrac{a+1}{a-1}$

Numerator – Denominator / Numerator + Denominator;

$$\therefore \frac{2\sqrt{12a^2-x}}{2x} = \frac{2}{2a}$$

$$\frac{\sqrt{12a^2-x}}{x} = \frac{1}{a}$$

$$12a^2 - x = \frac{x^2}{a^2}$$

$$\frac{x^2}{a^2} + x = 12a^2$$

$$x^2 + a^2x = 12a^4$$

$$x^2 + a^2x + \left(\frac{a^2}{2}\right)^2 = 12a^4 + \frac{a^4}{4}$$

$$= \frac{49a^4}{4}$$

$$x + \frac{a^2}{2} = \pm\frac{7a^2}{2}$$

$$x = \pm\frac{7a^2}{2} - \frac{a^2}{2}$$

$$x = 3a^2, \text{ or } -4a^2;$$

The minus value does not satisfy the equation.

$$\therefore \underline{x = 3a^2.}$$

(2) $x^3+3ax^2=4a^3$

$$x^3 - a^3 = 3a^3 - 3ax^2$$

$$= 3a(a^2 - x^2)$$

$$= -3a(x^2 - a^2)$$

Dividing by $(x-a)$;

$$\therefore x^2 + ax + a^2 = -3a(x+a)$$

$$= -3ax - 3a^2$$

$$x^2 + 4ax + 4a^2 = 0$$

Extracting square root, $x + 2a = 0$

$$\therefore \underline{x = -2a.}$$

As we divided by $x-a$, therefore a is one value of x;

$$\therefore \underline{x = a, \text{ or } -2a.}$$

(3) $\dfrac{x+\sqrt{x^2-1}}{x-\sqrt{x^2-1}} - \dfrac{x-\sqrt{x^2-1}}{x+\sqrt{x^2-1}} = 8\sqrt{x^2-1}$

$$\frac{(x+\sqrt{x^2-1})^2 - (x-\sqrt{x^2-1})^2}{(x-\sqrt{x^2-1})(x+\sqrt{x^2-1})} = 8\sqrt{x^2-1}$$

$$\frac{x^2+2x\sqrt{x^2-1}+x^2-1-(x^2-2x\sqrt{x^2-1}+x^2-1)}{x^2-(x^2-1)} = 8\sqrt{x^2-1}$$

$$\frac{2x^2-1+2x\sqrt{x^2-1}-2x^2+1+2x\sqrt{x^2-1}}{x^2-x^2+1} = 8\sqrt{x^2-1}$$

$$4x\sqrt{x^2-1} = 8\sqrt{x^2-1}$$

Dividing by $\sqrt{x^2-1}$;

$$4x = 8$$

$$\therefore \underline{x = 2.}$$

As we divided by $\sqrt{x^2-1}$, therefore $x^2 = 1$; wherefore $x = \pm 1$,

$$\therefore \underline{x = 2, \text{ or } \pm 1.}$$

2. VIRGIL.—Solve:

(1) $a^2x^2 - 2a^3x + a^4 - 1 = 0$,

(2) $4a^2x = (a^2 - b^2 + x)^2$.

(*Todhunter's* 'Algebra for Beginners.')

(1) $a^2x^2 - 2a^3x + a^4 - 1 = 0$

$$a^2x^2 - 2a^3x + a^4 = 1$$

$$x^2 - 2ax + a^2 = \frac{1}{a^2}$$

Extracting square root;

$$x - a = \pm\frac{1}{a}$$

$$\therefore \underline{x = a \pm \frac{1}{a}}$$

(2) $4a^2x = (a^2 - b^2 + x)^2$

$$= a^4 + b^4 + x^2 - 2a^2b^2 + 2a^2x - 2b^2x$$

$$-x^2 + 4a^2x - 2a^2x + 2b^2x = a^4 - 2a^2b^2 + b^4$$

$$x^2 - 2a^2x - 2b^2x = -(a^4 - 2a^2b^2 + b^4)$$

$$x^2 - 2(a^2 + b^2)x = -(a^4 - 2a^2b^2 + b^4)$$

$$x^2 - 2(a^2 + b^2)x + (a^2 + b^2)^2$$

$$= a^4 + 2a^2b^2 + b^4 - a^4 + 2a^2b^2 - b^4$$

$$= 4a^2b^2$$

$$x - (a^2 + b^2) = \pm 2ab$$

$$x = a^2 \pm 2ab + b^2$$

$$\therefore \underline{x = (a \pm b)^2.}$$

3. SUBSCRIBER.—One side of a triangle is half the sum of the two others; the sum of the three sides is 84 feet, and the area of the triangle is 14 square yards; find its sides.

Sum of sides = 28 yds.;

One side = $\frac{1}{2}$ sum of the two other sides

= $\frac{1}{4}$ " three sides

= $\frac{28}{4}$ yds.;

Sum of two other sides = $\frac{3}{4}$ of 28 yds.

= $\frac{84}{4}$ yds.;

Let x = one of the other sides in yds.,

Then, $\frac{84}{4} - x$ = the third side in yds.;

Half sum of sides = 14 yds.;

$$\therefore \sqrt{14 \times (14 - \tfrac{28}{4}) \times (14 - x) \times \{14 - (\tfrac{84}{4} - x)\}} = 14$$

$$\sqrt{14 \times \tfrac{14}{2} \times (14 - x) \times \frac{3x - 14}{3}} = 14$$

$$14\sqrt{\frac{14 - x}{3} \times \frac{3x - 14}{3}} = 14$$

$$\sqrt{\frac{56x - 3x^2 - 196}{9}} = 1$$

$$56x - 3x^2 - 196 = 9$$

$$3x^2 - 56x = -205$$

$$x^2 - \frac{56x}{3} = -\frac{205}{3}$$

$$x^2 - \frac{56x}{3} + (\tfrac{28}{3})^2 = \tfrac{784}{9} - \tfrac{205}{3}$$

$$= \frac{784 - 615}{9}$$

$$= \tfrac{169}{9}$$

$$x - \tfrac{28}{3} = \pm\tfrac{13}{3}$$

$$x = \pm\tfrac{13}{3} + \tfrac{28}{3}$$

$$\therefore \underline{x = 9\tfrac{1}{3}, \text{ or } 5.}$$

$\therefore$ Sides of triangle are $9\frac{1}{3}$ yds., $13\frac{2}{3}$ yds., and 5 yds.

4. SOLICITOR.—Out of 12 consonants and 5 vowels, how many words can be formed each containing 6 consonants and 3 vowels?

Out of 12 consonants we get $\frac{12\times11\times10\times9\times8\times7}{\lfloor 6}$ combinations of 6 consonants;

Out of 5 vowels we get $\frac{5\times4\times3}{\lfloor 3}$ combinations of 3 vowels;

$\therefore$ We get $\frac{12\times11\times10\times9\times8\times7}{\lfloor 6}\times\frac{5\times4\times3}{\lfloor 3}$ combinations of 6 consonants and 3 vowels;

Each combination gives rise to $\lfloor 9$ permutations;

$\therefore$ We get $\frac{12\times11\times10\times9\times8\times7}{\lfloor 6}\times\frac{5\times4\times3}{\lfloor 3}\times\lfloor 9$ words

$=3,353,011,200$ words. Ans.

5. W. TAYLOR.—Solve:—

$$\frac{6}{x-1}+\frac{8}{x-5}=\frac{7}{x+1}+\frac{18}{x+5}.$$

(*Todhunter's* 'Algebra for Beginners.')

$$\frac{6}{x-1}+\frac{8}{x-5}=\frac{7}{x+1}+\frac{18}{x+5}$$

$$\frac{6}{x-1}-\frac{7}{x+1}=\frac{18}{x+5}-\frac{8}{x-5}$$

$$\frac{6x+6-7x+7}{x^2-1}=\frac{18x-90-8x-40}{x^2-25}$$

$$\frac{-x+13}{x^2-1}=\frac{10x-130}{x^2-25}$$

$$-\frac{x-13}{x^2-1}=\frac{10(x-13)}{x^2-25}$$

Dividing by $(x-13)$

$$-\frac{1}{x^2-1}=\frac{10}{x^2-25}$$

$$-x^2+25=10x^2-10$$

$$-x^2-10x^2=-10-25$$

$$11x^2=35$$

$$x^2=\tfrac{35}{11}$$

$$\therefore\ x=\pm\sqrt{\tfrac{35}{11}}.$$

As we divided by $x-13$, therefore 13 is one value of x.

$$\therefore\ x=13,\text{ or }\pm\sqrt{\tfrac{35}{11}}.$$

6. R. H. L.—Given $\log_{10}2=\cdot301030$, and $\log_{10}7=\cdot845098$, find the logarithm of $(\frac{4}{35})^{\frac{1}{3}}$ to the base 1000. (*Todhunter.*)

Logarithm to the base 10.

$$\begin{aligned}\text{Log }(\tfrac{4}{35})^{\frac{1}{3}}&=\tfrac{1}{3}\log(\tfrac{4}{35})\\&=\tfrac{1}{3}\log\left(\frac{2^2}{7\cdot5}\right)\\&=\tfrac{1}{3}\log(2^3-7^3)\\&=\log2-\tfrac{3}{3}\log7\\&=\cdot301030-(\cdot845098\times\tfrac{3}{3})\\&=\cdot301030-1\cdot267647\\&=-\cdot966617\end{aligned}$$

Logarithm to the base 1000.

$$\begin{aligned}\text{Log }(\tfrac{4}{35})^{\frac{1}{3}}&=-\cdot966617\times\frac{1}{\log_{10}1000}\\&=-\cdot966617\times\tfrac{1}{3}\\&=-\cdot322205.\end{aligned}$$

7. YELDIR GONL.—A, B, and C are three brothers. Ten years ago A's age was twice B's; eight years ago B's was twice C's; and two years ago A's was twice C's. When did A come of age? (*College of Preceptors*, Midsummer, 1884.)

Let x=A's present age,
" y=B's " ",
And " z=C's " ",
Then (1) $x-10=2(y-10)$
(2) $y-8=2(z-8)$
(3) $x-2=2(z-2)$

(1) $x-2y=-10$
(2) $y-2z=-8$
(3) $x-2z=-2$
(2) $y-2z=-8$
(3) $x-2z=-2$

Subtracting, $-x+y=-6$

(1) $2x-2y=12$
$x-2y=-10$

Subtracting, $\therefore\ x=22.$

$\therefore$ A came of age a year ago.

Note.—Each correspondent is restricted to *one* question.

8. ST. AUBIN.—Solve:—

$$x\left\{1+\left(\frac{a}{x}\right)^{\frac{2}{3}}\right\}^{\frac{1}{2}}=b\left(\frac{a}{x}\right)^{\frac{1}{2}}.$$

$$x\left\{1+\left(\frac{a}{x}\right)^{\frac{2}{3}}\right\}^{2}=b\left(\frac{a}{x}\right)^{\frac{1}{2}}$$

$$=\frac{a^{\frac{1}{2}}b}{x^{\frac{1}{2}}}$$

Multiplying each side by $x^{\frac{1}{2}}$

$$x^{\frac{1}{2}}\left\{1+\left(\frac{a}{x}\right)^{\frac{2}{3}}\right\}^{2}=a^{\frac{1}{2}}b$$

Extracting square root of each side

$$x^{\frac{1}{2}}\left\{1+\left(\frac{a}{x}\right)^{\frac{2}{3}}\right\}=a^{\frac{1}{2}}b^{\frac{1}{2}}$$

$$x^{\frac{1}{2}}+a^{\frac{2}{3}}=a^{\frac{1}{2}}b^{\frac{1}{2}}$$

$$x^{\frac{1}{2}}=a^{\frac{1}{2}}b^{\frac{1}{2}}-a^{\frac{2}{3}}$$

$$x^2=\left(a^{\frac{1}{2}}b^{\frac{1}{2}}-a^{\frac{2}{3}}\right)^3$$

$$\therefore\ x=\pm\sqrt{\left(a^{\frac{1}{2}}b^{\frac{1}{2}}-a^{\frac{2}{3}}\right)^3}.$$

9. ESSAYIST.—A quantity of corn is to be divided among n persons, and is calculated to last a certain time, if each of them receive a peck every week; during the distribution it is found that one person dies every week, and then the corn lasts twice as long as was expected. Find the quantity of corn, and the time it was expected to last.

Let x=Time the corn was expected to last in weeks;
Then, nx=Quantity of corn in pecks;

We have an Arithmetical Progression, in which the first term is n, the difference -1, the no. of terms $2x$, and the sum nx.

$$S=\{2a+(n-1)d\}\frac{n}{2}$$

$$\therefore\ nx=[2n+\{(2x-1)\times-1\}]\times\frac{2x}{2}$$

$$=(2n-2x+1)\times x$$

Dividing each side by x,

$$n=2n-2x+1$$

$$2x=2n-n+1$$

$$=n+1$$

$$\therefore\ x=\frac{n+1}{2}.$$

$\therefore$ The corn was expected to last $\frac{n+1}{2}$ weeks;

The quantity of corn was $\frac{n(n+1)}{2}$ pecks.

Note.—No.

10. BLACKBIRD.—In a geometrical progression of 5 terms the difference of the extremes is to the difference of the 2nd and 4th terms as 10 : 3, and the sum of the 2nd and 4th terms equals twice the product of the 1st and 2nd. Find the series.

(1) $ar^4-a : ar^3-ar :: 10 : 3,$
$a(r^4-1) : ar(r^2-1) :: 10 : 3,$
$(r^4-1) : r(r^2-1) :: 10 : 3,$
$r^2+1 : r :: 10 : 3,$

$$\therefore\ 3(r^2+1)=10r$$

$$r^2+1=\frac{10r}{3}$$

$$r^2-\frac{10r}{3}=-1$$

$$r^2-\frac{10r}{3}+(\tfrac{5}{3})^2=\tfrac{25}{9}-1$$

$$=\tfrac{16}{9}$$

$$r-\tfrac{5}{3}=\pm\tfrac{4}{3}$$

$$r=\pm\tfrac{4}{3}+\tfrac{5}{3}$$

$$\therefore\ r=3,\text{ or }\tfrac{1}{3}.$$

(2) $ar+ar^3=a\times ar\times 2$

$a(1+r^3)=ar\times 2a$

$1+r^3=2a$

$a=\frac{1+r^3}{2}$

$=\frac{1+3^3}{2}$, or $\frac{1+(\frac{1}{3})^3}{2}$

$\therefore a=5$, or $\frac{5}{9}$.

$\therefore$ Series $=5,\ 15,\ 45,\ 135,\ 405$;

or, $\frac{5}{9},\ \frac{5}{3},\ 5,\ 15,\ 45$.

11. FRANCHISE.—Two partners, A and B, gained £140 by trade; A's money was 3 months in trade, and his gain was £60 less than his stock; and B's money, which was £50 more than A's, was in trade 5 months. What was A's stock? (*Piper.*)

Let x = A's stock in pounds;

Then,

$3x+5(x+50) : 3x :: 140 : x-60$;

$(8x+250)(x-60)=3x\times 140$

$8x^2-230x-15000=420x$

$8x^2-650x=15000$

$x^2-\frac{325x}{4}=1875$

$x^2-\frac{325x}{4}+(\frac{325}{8})^2=\frac{105625}{64}+1875$

$=\frac{105625+120000}{64}$

$=\frac{225625}{64}$

$x-\frac{325}{8}=\pm\frac{475}{8}$

$x=\pm\frac{475}{8}+\frac{325}{8}$

$\therefore x=100$, or $-\frac{75}{4}$.

$\therefore$ A's stock was £100.

—o—

Vere Foster's Writing and Drawing Copy-Books.

FIFTEENTH ANNUAL COMPETITION, 1885.

WE have pleasure in drawing the attention of our readers to the results of the recent popular Writing, Drawing, and Painting Competitions promoted by Mr. Vere Foster.

During the past year there have been 592 competitors in Ordinary Writing, 52 in Plain and Ornamental Lettering, 299 in Drawing, and 73 in Painting. Three hundred and seventy boys have competed, and five hundred and forty-seven girls, of whom 363 hail from Ireland, and 554 from Great Britain, 30 counties in Ireland being represented, 32 in England, 15 in Scotland, and 3 in Wales.

The Highest Prize for Ordinary Writing, £3, was awarded to Nannie Lynch, aged eleven, a pupil of Kilcock Parochial School, county Kerry; and the second, third, and fourth prizes, of £2 each, were awarded to three girls,—pupils respectively of the Methodist College, Belfast, Fohenagh National School, county Limerick, and Kilcock Parochial School, Kerry.

The following are the conditions of the Competition for 1885, open to pupils of either public or private schools throughout the United Kingdom not over 18 years of age on January 1, 1885, and not being apprentice lithographers:—

WRITING.—For the most faithful imitation of the headlines in my Copy-book No. 7 (or No. 8 of my Palmerston Series), each word, with exception of capitals and the small letter x, to be written continuously through without lifting the pen from the paper—one prize of £5, five prizes of £2, twenty-five prizes of £1, fifty prizes of 10s., and two hundred prizes of 5s. each. Total prizes, 281; amount, £115.

It will not be sufficient to copy the headline only once, but every ruled line should be written on.

I wish to impress upon teachers that, in order to acquire freedom of hand in the style of Copy-book No. 7, it is necessary that their pupils, of whatever age, should first be well grounded in the principles illustrated in the elementary books Nos. 1, 2, and 2½.

PLAIN AND ORNAMENTAL LETTERING.—For the most faithful copies of the whole of the headlines in my Copy-book No. 10—one prize of £5, ten prizes of £1, and twenty prizes of 10s. each. Total prizes, 31; amount, £25.

It will be sufficient to make one copy only of each headline in No. 10.

As conditions of the distribution of so large a sum I shall expect at least 2,000 competitors in Copy-book No. 7, and 200 in No. 10. Should the number exceed 2,000, additional prizes will be given.

DRAWING.—For the most faithful imitations of the examples in any of my books, A, B, C, D, E, G, I, J, K, M, O, Q, or T (geometry being omitted), the copies to be in every case drawn in the book (threepenny edition), the copy to be slightly enlarged or reduced from the original in due proportion—one prize of £1, three prizes of 10s., and six prizes of 5s. each. Total books, 45. Prizes, 450. Amount £180.

All lines, except in book T, must be drawn with pencil, and without the aid of ruler, compass, or other instruments.

There should be at least 100 competitors in any one book. Failing that number, I will reserve to myself the liberty of grouping the books in quantities of 100, or thereabouts. Should the number of competitors in any one book exceed 100, the number of prizes of each class, except the first, for copies of that particular book will be increased.

WATER COLOUR PAINTING.—For the most faithful copies of any *four* studies in colours in any one of the following subjects contained in my books, namely:—Flowers, Landscape in Sepia, Landscape in Water Colours, Marine, Animals, Illuminating. For each subject one prize of £1, three prizes of 10s., and six prizes of 5s. Total subjects, 6. Prizes, 60. Amount, £24. There should be at least thirty competitors in each subject. Arrangements have been made to reprint the examples of Landscape in Sepia and Landscape in Water Colours, and they will shortly be in the hands of booksellers.

Extra prizes are offered for the advanced works in Water Colours recently added to the Series, and published by Messrs. Blackie and Son, viz.—EASY STUDIES IN WATER COLOURS, TREES IN WATER COLOURS, and SKETCHES IN WATER COLOURS, by various Artists—for any four drawings of each subject one prize of £1 10s., three prizes of 15s. each, and six prizes of 7s. 6d. each. Total subjects, 3; Prizes, 30; Amount, £18. There should be at least thirty competitors in each subject.

In PAINTING there will be no limit of age or restriction to schools, professional artists or teachers only being excepted. *The Committee of Examiners on* PAINTING *wish me to suggest that in future competitions the Copies should* NOT *be enlarged or drawn on too rough paper. The paintings should not be mounted on paper of a larger size than the Copy-books.*

Each prize will be accompanied by a handsome certificate of merit.

The following particulars, signed by the teacher, should accompany each book, written on the front of the cover:—Name of pupil; age on January 1, 1885; name and address of school; average number of pupils in daily attendance during the preceding twelve months.

Winners of the highest prize in any subject may not, as a rule, compete again in that subject; but such may compete for the prizes offered below for the South Kensington Series.

The books should be delivered, carriage paid, addressed to Vere Foster, care of Blackie and Son, 89, Talbot Street, Dublin, on or before April 30, 1885. Communications of the nature of a letter should not be enclosed in book-post parcels, but should be sent separately on post-cards or otherwise.

All writing-books for which prizes under £2 shall have been awarded will be returned to the writers, if desired, on receipt of address and stamps for postage; also all Drawing and Ornamental Lettering Books, whether belonging to successful or unsuccessful competitors, with the exception of those books for which the higher prizes may be awarded, of which a selection will be retained for exhibition.

Prize Lists will be sent to all competitors, and will be furnished to the *Schoolmaster*, the *Irish Teachers' Journal*, and other Educational Journals.

VERE FOSTER.

BELFAST, *July* 1, 1884.

Poynter's South Kensington Drawing-Books.

In order to encourage a further development of Drawing, on the more strictly academic lines (such as required for Art Students by the Department of Science and Art), the following prizes are offered (for 1884-5), on conditions similar to Vere Foster's Competition in Drawing.

FIRST GRADE FREEHAND. ORNAMENT, PLANTS, ELEMENTARY FIGURE (in all, 18 Books).—For the most faithful copies of the Examples in any two books, *drawn in the books*. For each series—one prize of £1, two prizes of 10s., and six prizes of 5s. Total, £10 10s.

There must be at least 100 *competitors in each of the three series.*

SECOND GRADE FREEHAND. ORNAMENT (4 Books).—For the best copies of any two books, *drawn in the books*, one prize of £2, two prizes of £1, and six prizes of 10s. Total, £7.

There must be at least 50 *competitors.*

HUMAN FIGURE. LARGE HEADS (3 Books). FIGURES FROM THE CARTOONS (4 Books).—For the most faithful copies of any two books, *drawn in the books*. For each series, one prize of £3, two prizes of £1 10s., six prizes of 15s. Total, £21.

There must be at least 50 *competitors in each series.*

Illustrated List of POYNTER'S SOUTH KENSINGTON DRAWING-BOOKS sent on application to the Publishers, BLACKIE & SON, 49, Old Bailey, LONDON; 17, Stanhope Street, GLASGOW; and 89, Talbot Street, DUBLIN.

VERE FOSTER'S WRITING AND DRAWING COPY-BOOKS may be obtained *through any local Bookseller*, or post free for the price in stamps, direct from the Publishers, BLACKIE & SON, 49 and 50, Old Bailey, LONDON; 17, Stanhope Street, GLASGOW; or 89, Talbot Street, DUBLIN.

GILL'S SCHOOL SERIES.

GILL'S 'ALBANY'

ELEMENTARY SCIENCE READERS.

The Education Code of 1882-3 has placed Elementary Science on Schedule II. as a Class Subject which may be taken instead of Geography. It also prescribes a Course. The Code further says that, above Standard II., the subject should be taught through Reading Books.

GEORGE GILL & SONS have therefore prepared a complete set of Readers for this subject, which are now ready, as follows:—

No. 1.—'Albany' Science Readers. Standard III. Common Objects, Animals, Plants, etc. 160 pp., 1s.

For those who take, above Standard III., the Section of the Code marked (*a*) viz.:—

ANIMALS AND PLANTS, with particular reference to Agriculture.

No. II.—'Albany' Science Readers. Standard IV. First Course. Animals and Plants. 168 pp., 1s.

No. III.—'Albany' Science Readers. Standard V. First Course. Animals and Plants. 168 pp., 1s.

No. IV.—'Albany' Science Readers. Standard VI. First Course. Animals and Plants. 184 pp., 1s. 6d.

For those who take, above Standard III., the Section of the Code marked (*c*) viz.:—

PHYSICS.

No. II.—'Albany' Science Readers. Standard IV. Second Course. Physics (as in the Code). 160 pp., 1s.

No. III.—'Albany' Science Readers. Standard V. Second Course. Physics (as in the Code). 160 pp., 1s.

No. IV.—'Albany' Science Readers. Standard VI. Second Course. Physics (as in the Code). 176 pp., 1s. 6d.

NOTE.—We have received a letter from the Department, saying that either of these Sections of the Code (*a*, *b*, or *c*) satisfies the Standard requirements.

Whilst entirely satisfying the scope of the Code, we have most carefully incorporated the excellent scheme arranged by the London School Board for this subject in their Schools.

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